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Characterization of Exhaust Emissions from Operation of a Light-Duty Gasoline Vehicle on Alternate Source Gasoline Fuels

Southwest Research Inst., San Antonio, TX

Prepared for

Environmental Protection Agency, Ann Arbor, MI

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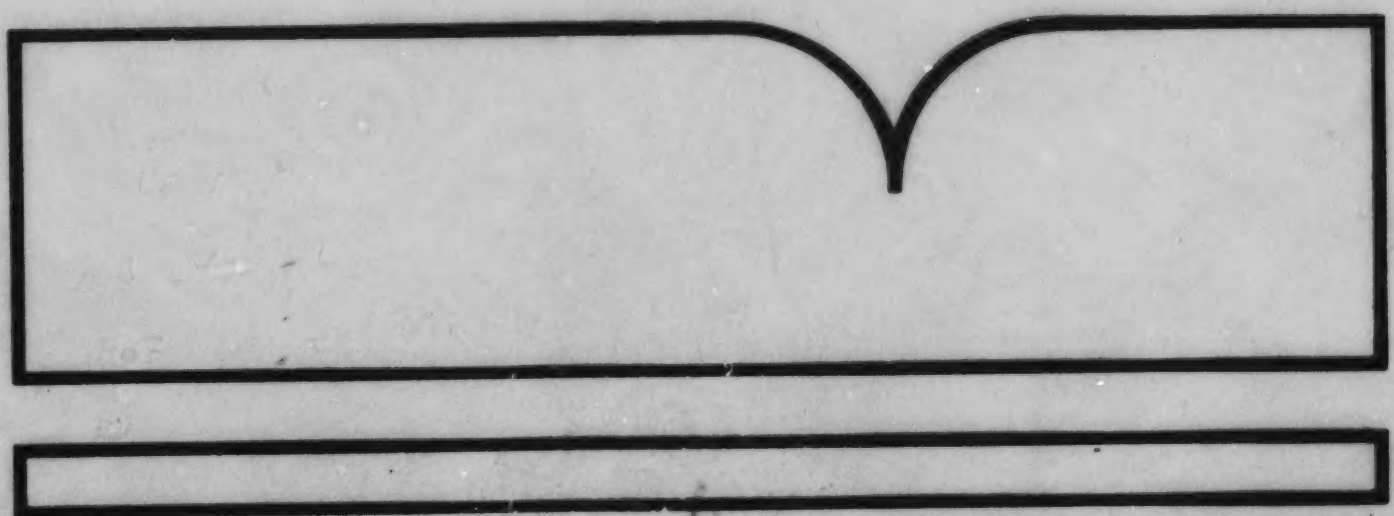

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This report describes the laboratory effort to characterize regulated and unregulated exhaust emissions from a 1981 Volkswagen Rabbit operating on Amoco Indolene gasoline and five alternate-source fuels or fuel blends. These five alternate-source fuels included Mobil MTG gasoline, Simulated Coal gasoline, EDS Naphtha blend, Sasol blend (lead chemically removed), and H-Coal Naphtha blend. The test vehicle was operated over the Light-Duty Federal Test Procedure (FTP) and the Highway Fuel Economy Driving Schedule (HFET). Exhaust constituents measured, in addition to the regulated emissions, included aldehydes and ketones, particulate, individual hydrocarbons, sulfate ammonia, cyanide, organic amines, organic sulfides, phenols, nitrosamines, benzo(a)-pyrene and major elements in particulate.

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back of TP

FOREWORD

The original purpose of Contract 68-03-2377, begun in 1976, was to determine emission effects of gasolines made from coal and oil shale. The fuels themselves were unavailable at the time, but probable fuel compositions were estimated from data on crude stocks made from coal and oil shale. Task One of the project resulted in the December, 1976 EPA-460/3-76-035 report, "Impact of Coal and Oil Shale Products on Gasoline Composition, 1976-2000."

Due to test fuel unavailability, work was deferred until 1978, at which time some of the efforts were redirected into determining the emissions effects of alcohol-gasoline mixtures. This Task Six project resulted in the October, 1979 report, "Gasohol, TBA, MTBE Effects on Light-Duty Emissions."

Beginning in 1981 and ending in 1983, several alternate-source gasolines became available which permitted the completion of the program on the subject originally intended, resulting in this report. The entire Contract was performed for the U.S. Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan, 48105. The EPA Project Officer was Mr. Robert J. Garbe, and SwRI Principal Investigators were Messrs. Charles T. Hare, Bruce B. Bykowski, John A. Russell, and Dr. Lawrence R. Smith. The project was identified within SwRI as (initially) 11-4493 and (later) 05-4493.

ABSTRACT

This report describes the laboratory effort to characterize regulated and unregulated exhaust emissions from a 1981 Volkswagen Rabbit operating on Amoco Indolene gasoline and five alternate-source fuels or fuel blends. These five alternate-source fuels included Mobil MTG gasoline, Simulated Coal gasoline, EDS Naphtha blend, Sasol blend (lead chemically removed), and H-Coal Naphtha blend. The test vehicle was operated over the Light-Duty Federal Test Procedure (FTP) and the Highway Fuel Economy Driving Schedule (HFET). Exhaust constituents measured, in addition to the regulated emissions, included aldehydes and ketones, particulate, individual hydrocarbons, sulfate, ammonia, cyanide, organic amines, organic sulfides, phenols, nitrosamines, benzo(a)pyrene and major elements in particulate.

SUMMARY

The major objective of this program was to evaluate the effects of available alternate-source fuels or fuel blends on the exhaust emissions of a gasoline-powered 1981 Volkswagen Rabbit. The fuels tested in this program included: Amoco Indolene as a baseline reference fuel, Mobil MTG gasoline, Simulated Coal gasoline, EDS and H-Coal Naphtha gasoline blends, and a de-leaded Sasol gasoline blend. The test vehicle was operated over two driving schedules, the Light-Duty Federal Test Procedure (FTP), and the Highway Fuel Economy Test (HFET). Additional multiple Urban Dynamometer Driving Schedule (UDDS) and multiple HFET tests were used to generate particulate samples for extractions of organic soluble material.

The exhaust emissions evaluated in this program included the regulated emissions (hydrocarbons, carbon monoxide, and oxides of nitrogen), particulate, aldehydes and ketones, selected individual hydrocarbons, sulfate, ammonia, cyanide, organic amines, organic sulfides, phenols, nitrosamines, benzo(a)pyrene, and elemental constituents of particulate.

The most important observations and conclusions reached as a result of this project (not necessarily in order) are listed below. Unless stated otherwise, all fuels will be compared to the base fuel.

1) The test car met the 1981 Federal Emission Standards for hydrocarbons, carbon monoxide, and oxides of nitrogen with all six test fuels.

2) The five alternate fuels all gave higher NO_x emission rates than the base fuel. However, the NO_x emission rates also appeared to increase with time, with each subsequent test fuel evaluated giving equivalent or slightly higher NO_x emissions than the previous fuel, indicating the possibility of a drift in the vehicle emission control system.

3) In general, the fuel consumption rate did not vary from fuel to fuel more than three percent, the nominal value for test-to-test repeatability using the same fuel. The Simulated Coal gasoline, however, gave the largest deviation from the base fuel in fuel consumption (7 percent lower than the base fuel for the FTP test cycle). This lower rate may be due to the higher density and carbon percentage of the Simulated Coal gasoline, resulting in a higher energy density for the fuel.

4) Hydrocarbon emissions varied from fuel to fuel and from cycle to cycle with no apparent relationship to fuel properties.

5) Both Naphtha blends (EDS and H-Coal) gave higher carbon monoxide emissions than the base fuel, while the Simulated Coal gasoline gave lower emissions than the base fuel. The reasons for these variations are not readily apparent.

6) The Sasol blend fuel gave exceedingly high particulate emission rates. The major portion of this particulate was found to be chlorine and bromine by trace element analysis. The Sasol gasoline used in this program originally contained lead, which was chemically removed before the fuel was used in the test program. The lead removal process, however, did not remove the halogens, chlorine and bromine, which are normally found in leaded fuels. The high particulate emission rate for the Sasol blend was found to be a direct result of the halogen content in the fuel.

7) The unregulated emissions were, in general, similar to those recorded in previous programs, which evaluated vehicles with emission control systems similar to the test car used in this program.

8) Fuel nitrogen content appears to have had little effect on the nitrogen-containing unregulated emissions, in that the EDS and H-Coal Naphtha blends, which had high fuel nitrogen content as compared to the other test fuels (>10 fold higher), gave ammonia and cyanide emission rates equal to or lower than the other test fuels. The only fuel to produce a noticeable higher nitrogen content than the remaining fuels in the organic extractable portion of the particulate was the Mobil MTG gasoline, which had a comparatively low level of fuel nitrogen.

9) Fuel sulfur content appeared to have little or no effect on the sulfate emissions, with the high sulfur content fuels giving sulfate emissions equivalent to the other fuels.

TABLE OF CONTENTS

		Page
FOREWORD		iii
ABSTRACT		iv
SUMMARY		v
LIST OF FIGURES		viii
LIST OF TABLES		ix
I.	INTRODUCTION	1
	A. Project Objective	1
	B. Emission Measurement Procedures	1
	C. Test Vehicle	2
	D. Fuels Evaluated	2
	E. Vehicle Testing	2
II.	GENERAL EQUIPMENT, INSTRUMENTS, PREPARATIONS AND PROCEDURES	3
	A. Automobile	3
	B. Fuel Source, Fuel Properties and Blending Details	4
	C. Dynamometer and CVS System	6
	D. Exhaust Sampling and Analysis	8
	E. Instrumentation and Regulated Emissions	8
	F. Large Filter Samples	8
	G. Emissions Test Procedures	10
	H. Test Numbering System	14
	I. Computational Methods	15
III.	ANALYTICAL PROCEDURES FOR UNREGULATED EMISSIONS	17
	A. Description of the Analytical Procedures	17
	B. Validation and Qualification of the Analytical Procedures	21
	C. Accuracy of the Analytical Procedures	21
IV.	VEHICLE TESTING	27
	A. Vehicle - Fuel Evaluations	27
	B. Regulated and Unregulated Emission Tests Results	29
	C. Large Filter Sampling and Results	29
V.	ANALYSES OF THE RESULTS	33
	A. Regulated Emissions and Fuel Consumption	33
	B. Individual Hydrocarbon Emissions Data	35
	C. Aldehyde and Ketone, Particualte, Sulfate, Ammonia, and Cyanide Emissions	35
	D. Trace Element Emissions	38
	E. Other Unregulated Emissions	40
REFERENCES		41
APPENDICES		

LIST OF FIGURES

Figure		Page
1	1981 Volkswagen Rabbit used in fuel evaluations	3
2	Views of the emissions sampling system	7
3	Emissions sampling system	9
4	Driving cycle speed vs time traces	14

LIST OF TABLES

Table		Page
1	Test Vehicle Description	3
2	Properties of Test Fuels	5
3	Description of Four-Cycle FTP	10
4	Test Sequence for Each Fuel Evaluated	12
5	Laboratory Test Sequence	12
6	Laboratory Test Sequence for Multiple UDDS Tests	13
7	Laboratory Test Sequence for Multiple HFET Tests	13
8	Summary of Driving Schedule Parameters	14
9	Sampling and Analysis Methodology for Unregulated Emissions	18
10	Procedural Validation and Qualification	22
11	Emission Procedural Sample Rates and Accuracy	24
12	Project Test Matrix	28
13	Baseline Emissions and Fuel Consumption	27
14	Particulate and Organic Extractables from Large Filter Sampling	31
15	Benzo(a)pyrene and Major Elements in Organic Solubles from Particulate Matter	31
16	Summary of the Average Regulated Emissions and Fuel Consumption Data	33
17	Fuel Densities and Carbon Percentages for the Six Fuels	34
18	Summary of the Average Individual Hydrocarbon Data	36
19	Summary of Particulate, Sulfate, Ammonia, Cyanide, and Aldehyde and Ketone Emissions	37
20	Trace Element Emissions - Sasol and H-Coal Naphtha Blends Only	39
21	Trace Element Emissions - All Fuels	39

I. INTRODUCTION

Due to concerns over this country's dependence on foreign suppliers for its petroleum fuels supply, interest in alternate-source fuels, such as those derived from coal and shale oil, has increased. Because the alternate-source fuels differ in origin and processing from standard petroleum-derived gasolines, the exhaust emissions from automobiles fueled with the alternate-source materials may differ from the emissions produced by automobiles fueled with petroleum-based gasoline. This report describes the effort to characterize regulated and unregulated exhaust emissions from a 1981 Volkswagen Rabbit operating on Amoco Indolene gasoline and five alternate-source fuels or fuel blends. This program parallels a similar program conducted at SwRI involving the evaluation of emissions from a 1980 diesel-powered Volkswagen Rabbit, fueled with eight alternate-source diesel fuels.[1]*

This is one of several programs to be completed at SwRI involving a large number of unregulated emissions from automobiles. The previous projects involved malfunctioning automobiles[2,3,4,5], automobiles designed for low-NO_x operation[6], high mileage catalyst-equipped automobiles[7], automobiles fueled with methanol[8], and automobiles operating at idle and at low speeds.[9]

A. Project Objective

The primary objective of this project was to evaluate regulated and unregulated exhaust emissions from a 1981 Volkswagen Rabbit operating on various alternate-soruce fuels or fuel blends. A total of 6 fuels including Amoco Indolene as a base fuel were evaluated in this program.

B. Emission Measurement Procedures

The compounds or groups of compounds evaluated, along with the sampling methods used, were as follows:

Sampling Methods	Compounds Evaluated
Bags	HC, CO, NO_x, CO_2, individual HC
Filter	Particulates, sulfate, metals and other elements, organic soluble fraction of particulates for carbon, hydrogen, oxygen and nitrogen analysis, and benzo(a)pyrene determinations.
Impinger	Cyanides, aldehydes, ammonia, organic amines, and phenols
Trap	Nitrosamines and organic sulfides.

*Numbers in parentheses designate references at the end of this report.

Several of these procedures for measuring the unregulated emissions were developed in another project and reported in a widely distributed interim report.[10]

C. Test Vehicle

The 1981 VW Rabbit used in this program was fuel-injected and equipped with a three-way catalyst. The vehicle was obtained through the EPA Project Officer on loan from Volkswagen of America (Mr. Dan Hardin and Mr. Larry Nutson are among those responsible for this loan).

D. Fuels Evaluated

Six fuels were evaluated in this program, five alternate source fuels or fuel blends and Amoco Indolene as a base fuel. The five alternate-source fuels or fuel blends included: Simulated Coal Gasoline, EM-468-F; EDS Naphtha Blend, EM-488-F; H-Coal Naphtha Blend, EM-543-F; Mobil "MTG" (Methanol-to-Gasoline) Gasoline, EM-486-F; and Sasol Coal Gasoline Blend, EM-542-F. These fuels are described in detail in Section II-B.

E. Vehicle Testing

The VW Rabbit was tested with each fuel in duplicate over the Light-Duty Federal Test Procedure (FTP)[11], and once over the Highway Fuel Economy Driving Schedule (HFET).[12] Additional multiple Urban Dynamometer Driving Scheldues (UDDS) and HFET runs were used to generate particulate samples for subsequent carbon, hydrogen, nitrogen and oxygen analysis, and benzo(a)pyrene determinations.

II. GENERAL EQUIPMENT, INSTRUMENTS, PREPARATIONS AND PROCEDURES

This section describes the automobile, the fuels, the facilities, and the general instrumentation and procedures utilized in this project. The overall sampling systems for the unregulated emissions are also discussed.

A. Automobile

A 1981 Volkswagen Rabbit was used for all fuel evaluations performed in this program. The automobile is described in detail in Table 1, and is shown in Figure 1. The automobile was obtained through the project

TABLE 1. TEST VEHICLE DESCRIPTION

Vehicle Model	Volkswagen Rabbit
Model Year	1981
Body Type	4-dr
VIN	IVWGB9171BY085460
Engine Disp.	1.6ℓ
Cylinders	4
Fuel Delivery	Injected
Transmission	Auto-3

Chassis Dynamometer - Inertia Setting 1134 kg (2500 lbs.)
Chassis Dynamometer - Power Setting 5.7 kilowatts (7.7 Hp)

officer and had been used in two other EPA contracts at SwRI; EPA contracts 68-03-2884 (Task Specifications 11 and 12) and 68-03-3073 (Work Assignments 1 and 4).

Figure 1. 1981 Volkswagen Rabbit used in fuel evaluations

B. Fuel Sources, Fuel Properties and Blending Details

Including the base fuel, six materials were tested in the emissions evaluation phase of the program. Table 2 lists the fuel properties for each of the materials tested in the program. A brief history of each fuel, and blending steps used to formulate it, if any, are given below:

1. Base Petroleum Gasoline, Fuel Code No. EM-338-F

   The base fuel, also used as a blend stock for several of the test fuels, was Amoco "Indolene" emission test gasoline. The particular lot used was received in 1978, stored in an underground tank, and analyzed periodically to make sure it did not deteriorate. Its research octane number was 97.7, and its RVP was 9.0 psi.

2. Simulated Coal Gasoline, Fuel Code No. EM-468-F

   In response to the needs of this project as well as those of a program for DOE being performed by another SwRI Department, a gasoline was formulated by SwRI to contain approximately 58% simulated H-coal reformate and 42% petroleum derived components. This material was blended late in 1980, and was kept in cold storage until needed. Since this fuel was blended to approximate commercial gasoline specifications, it was not necessary to add base gasoline to it for acceptable performance. Sources for the blending components included DuPont, Koppers, and Howell Hydrocarbons.

3. EDS Naphtha Blend, Fuel Code No. EM-488-F

   The EDS (Exxon Donor Solvent) Naphtha itself, coded EM-481-F, was received in July of 1981. The material was obtained by Mr. Joe McSorely of EPA-IERC at the request of the Project Officer. Naphtha from the EDS process, like that from other solvent refining processes, is more a byproduct than a main stream product. This particular material was made at Exxon's Baytown plant. Properties of the EDS Naphtha are listed in Appendix A-1. The decision to use only 25% EDS Naphtha in the blend was made in order to prevent depressing the blend octane number and RVP too severely. As it turned out, it was necessary to add 6% low-boiling components to the 25/75 blend to boost the RVP just above 9.2 psi, and the octane number came in just about as expected at 92.3 (RON).

4. H-Coal Naphtha Blend, Fuel Code No. EM-543-F

   The neat H-Coal Naphtha was received in April of 1982, and was coded EM-513-F. This liquid was also obtained for us by Mr. Joe McSoreley of EPA-IERL at the request of the Project Officer. Properties of the Naphtha can be found in Appendix A-1. In this case, we were able to use 37% H-Coal Naphtha with 5% n-butane

TABLE 2. PROPERTIES OF TEST FUELS

Fuel Code Description	EM-338-F Base Petroleum Gasoline	EM-486-F Mobil "MTG" Gasoline from Coal	EM-468-F Simulated Coal Gasoline	EM-488-F EDS Naphtha Blend	EM-542-F Unleaded Sasol Blend	EM-543-F H-Coal Naphtha Blend
Gravity, °API	60.6	58.8	53.6	56.7	62.5	54.0
Density, g/mℓ	0.737	0.744	0.764	0.7559	0.7294	0.7628
Octane, research (RON)	97.7	92.7	91.3	92.3	90.0	90.7
Octane, motor (MON)	89.5	82.8	81.8	84.2	81.6	82.7
RVP, psi	8.9	9.7	10.7	9.2	10.3	10.3
Carbon, %	85.66±0.28	86.42±0.09	87.23	85.11±0.11	85.77±0.04	85.47±0.17
Hydrogen, %	13.81±0.07	13.65±0.06	12.66	13.61±0.03	14.00±0.07	13.61±0.06
Nitrogen, ppm		<10	no data	115	4±1	727
Sulfur, %	0.009	<0.001	0.007	0.13	<0.01	0.12
Lead, g/gal	<0.002	<0.001		<0.005	<0.01	<0.01
Aromatics, %	22.8	33.3	35.41	21.26	21.0	24.8
Saturates, %	75.2	64.4	64.59	78.74	68.4	73.3
Olefins, %	2.0	2.3		0.00	10.6	1.9
Oxid. Stability, min	600.	480.	>1440.	>1440.	>1440.	>1440.
Gum, unwashed, mg/100 mℓ	2.2	1.2	8.3	14.2	18.3	60.1
Gum, washed, mg/100 mℓ	0.7	0.2	3.3	14.2	13.4	58.7
Distillation - D86 °C (°F)						
IBP	33(92)	31(88)	27(81)	32(90)	27(81)	29(84)
5%	39(103)	39(103)	38(101)	39(102)	39(102)	43(110)
10%	49(121)	47(116)	49(120)	56(133)	48(119)	55(131)
15%			58(136)	70(158)	56(133)	68(154)
20%	69(156)	57(135)	67(152)	83(180)	64(148)	82(179)
30%	87(188)	69(156)	83(182)	100(212)	81(178)	99(211)
40%	97(206)	82(180)	97(206)	109(227)	94(202)	109(229)
50%	103(217	100(212)	108(227)	114(237)	106(222)	117(242)
60%	108(226)	120(248)	119(246)	121(252)	114(238)	126(258)
70%	114(237)	138(280)	132(270)	133(272)	124(255)	139(282)
80%	125(257)	153(307)	150(302)	150(302)	138(281)	158(316)
90%	154(309)	166(330)	181(358)	166(330)	159(318)	178(352)
95%	168(334)	178(352)	199(390)	178(352)	171(340)	206(403)
EP	208(406)	204(400)	213(416)	201(394)	207(404)	213(416)
Recovery, %	95.0		98.5	95.0	99.0	96.0
Residue, %		1.2	1.0	1.5	1.0	1.0

and 58% EM-338-F base fuel, because the effective blending octane number of this Naphtha was higher than that of the EDS Naphtha. The H-Coal Naphtha blend ended up with an RVP of 10.3 psi and an octane number of 90.7 (RON).

5. Mobil "MTG" Gasoline, Fuel Code No. EM-486-F

This test fuel, named "MTG" for the Mobil "Methanol-to-Gasoline" process, was the only one of the five coal-derived materials received as a specification-quality fuel and requiring no treatment or blending. It was received by SwRI in July of 1981 directly from Mobil, representing part of a pilot plant run made earlier that year at the Paulsboro, N.J., Research and Development facility. We requested the fuel through Mr. William Koehl of Mobil in 1980, and were contacted by Mr. John Warner when it was ready for shipment.

6. SASOL Coal Gasoline Blend, Fuel Code No. EM-542-F

Attempts to purchase Sasol gasoline began when this project was initiated in 1975, but were unsuccessful at that time due to their policy on release of samples for testing. We made contact with Sasol again in 1980, and succeeded in obtaining one drum of leaded, coal-derived gasoline and three drums of coal-derived diesel fuel for use in other projects. Delivery was made late in 1982 (fuel properties listed in Appendix A-1).

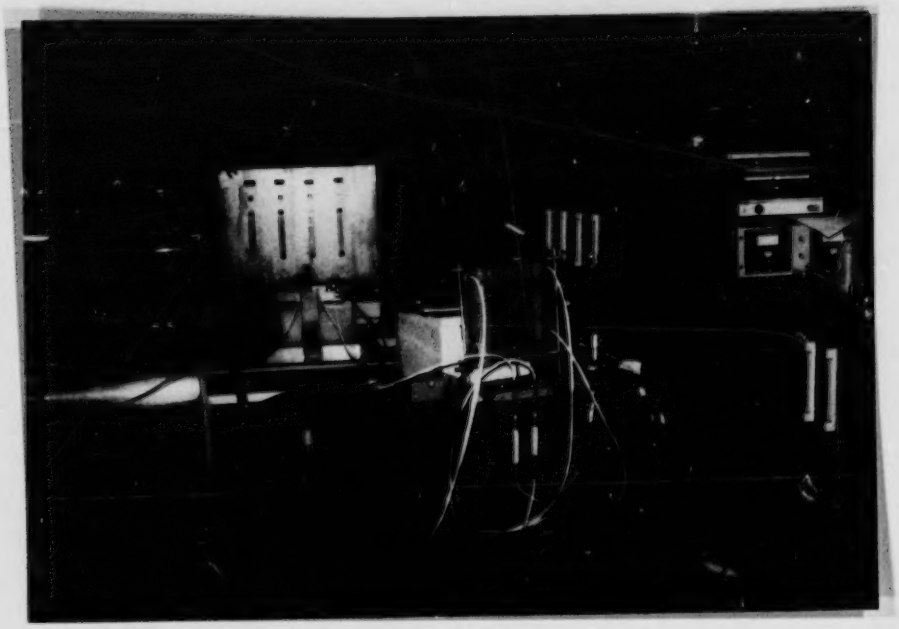
It was necessary to remove the lead antiknock additive from the gasoline prior to use, and also to blend with n-butane and base fuel to boost RVP and octane number. The process by which the lead was removed from the gasoline is described in Appendix A-2. The blend used was 48.3% de-leaded Sasol, 3.4% n-butane, and 48.3% base fuel, resulting in an RVP of 10.3 psi and an octane number of 90.0 (RON).

C. Dynamometer and CVS System

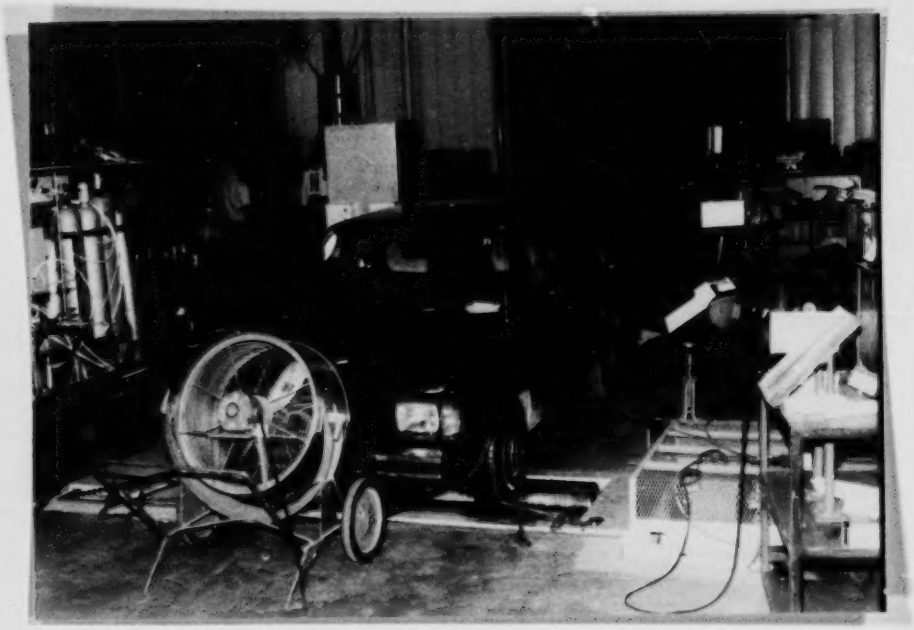
A Clayton Model ECE-50 chassis dynamometer with a direct-drive variable-inertia flywheel system was utilized for all transient testing. This direct-drive inertia system simulates equivalent weight of vehicles from 455 kg (1000 lb) to 4025 kg (8875 lb), in 55 kg (125 lb) increments.

The constant volume sampler (CVS) used for these evaluations was SwRI CVS Number 2. This unit has a nominal capacity of 9.2 m^3/min (325 cfm). A nominal 460 mm (18 inch) diameter by 5 m (16 foot) long dilution tunnel was used between the intake filter and the CVS to enable sampling of particulates.

Partial views of the chassis dynamometer, the dilution tunnel and the intake to the CVS can be seen in Figure 2. Both the dynamometer and the CVS



CVS Side of System



Dynamometer Side of System

Figure 2. Views of the emissions sampling system

were calibrated, maintained and operated in accordance with the manufacturer's instructions and the appropriate sections of the Code of Federal Regulations applicable to light-duty vehicles.[11]

In addition to the 142 m^3/min (5000 cfm) cooling fan placed in front of the automobile, 42 m^3/min (1500 cfm) blowers were available to cool each drive wheel. These additional blowers were used only during the HFET driving cycle.

D. Exhaust Sampling Analysis

A pictorial schematic of the exhaust and sampling system is shown in Figure 3. This system is in accordance with the guidelines established in previous unregulated emission projects conducted at SwRI for the EPA. The primary feature of this system is the number of sampling probes and systems necessary to collect all of the required unregulated emission samples. This complexity is illustrated in the views of the system shown in Figure 2.

This section has described the dilution tunnel and provided some insight into the overall sampling system assembly. More details on each of the individual sampling systems for the unregulated emissions are given in Section III.

E. Instrumentation for Regulated Emissions

Bagged samples of the dilute exhaust were evaluated for HC, CO, NO_x, and CO_2 using SwRI Bag Cart Number 1. This bag cart was designed, calibrated and operated in accordance with the appropriate sections of the Code of Federal Regulations applicable to light-duty vehicles.[11]

F. Large Filter Samples

To obtain particulate samples for determining the soluble organic fraction of particulate, as well as the elemental composition and benzo(a)-pyrene content of this soluble organic fraction, a system that allows the simultaneous collection of particulate on four 500 mm by 500 mm (20 inch by 20 inch) Pallflex filters was used in place of the regular CVS. Due to the low particulate emission rate of gasoline-fueled automobiles, such a system is necessary to obtain sufficient quantities of particulate for extraction and subsequent analyses. This 20x20 filter system permits the collection of the total particulate generated by the automobile during a test cycle. The 20x20 filter system is attached to the sampling end of the dilution tunnel and consists of a positive displacement blower with four associated in-line 20x20 filters and filter holders, temperature and flow-rate controllers, and readouts. The nominal flowrate is held at 0.217 m^3/s (460 scfm) by maintaining a constant temperature, using a heat exchanger, and a contant pressure drop across the blower. With this flowrate, there was no difficulty in maintaining the tunnel temperature below 43°C (110°F). Maximum temperature was about 35°C (95°F) in most of the cycles.

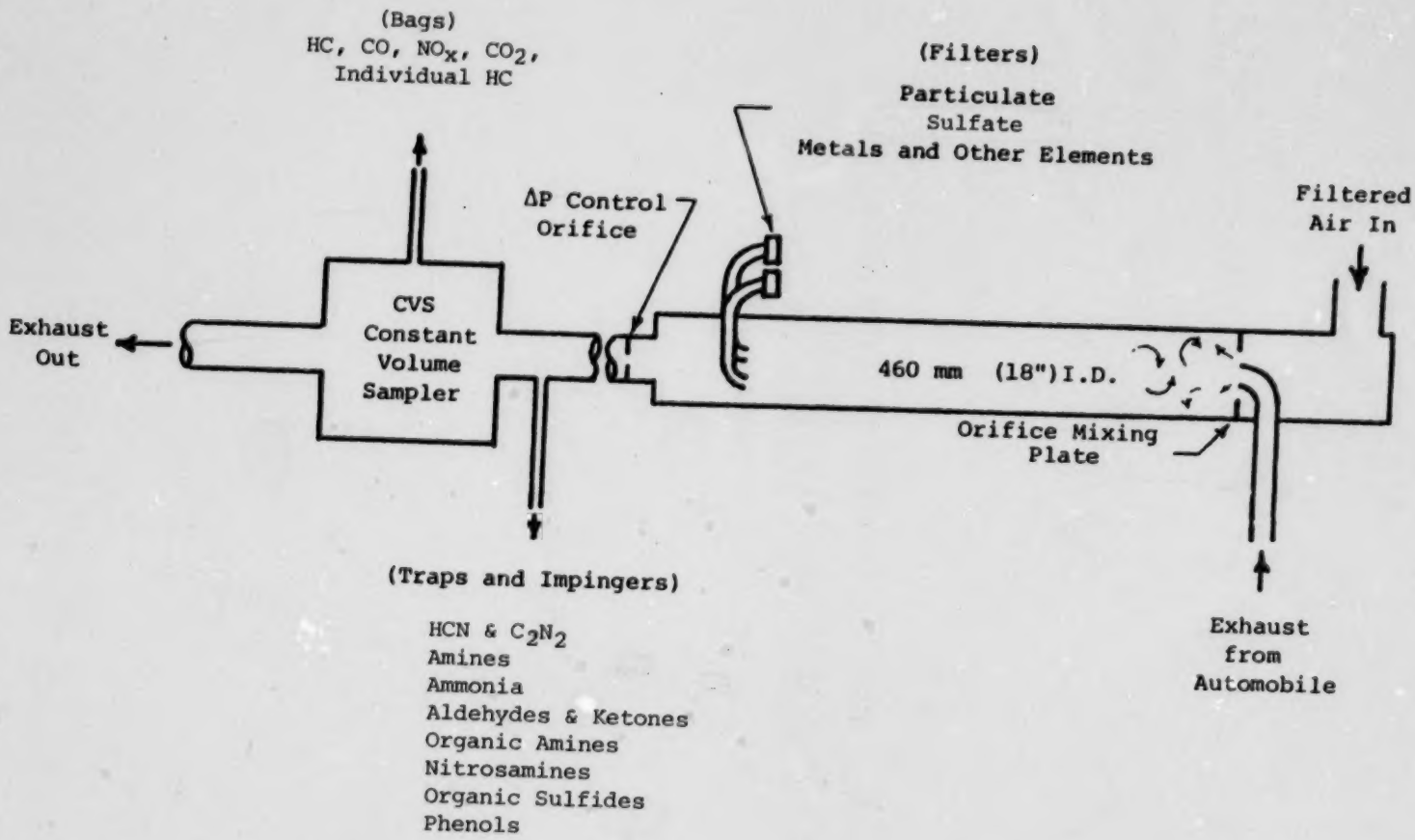


Figure 3. Emissions sampling system

G. Emissions Test Procedures

The primary procedures and driving schedules utilized in this project are defined as follows:

FTP - 1981 Federal Test Procedure[11]
(uses the Urban Dynamometer Driving Schedule)

HFET - Highway Fuel Economy Driving Schedule[12]

Each of the two primary procedures and schedules requiring emissions testing in this project (FTP and HFET), utilized bagged samples for evaluation of regulated emissions and fuel consumption.

The HFET is a hot-start, single-segment driving cycle. The FTP, however, involved cold-start and hot-start, multi-cycle with multi-segment operation. In addition, in this project, a four-bag FTP was utilized for most of the unregulated emissions, rather than the three-bag FTP specified in the Federal Test Procedure. Therefore, before proceeding, it is important to clarify the meaning of FTP as used in this project.

FTP - The FTP uses the Urban Dynamometer Driving Schedule (UDDS) which is 1372 seconds in duration. The UDDS, in turn, is divided into two segments: A "transient" phase of 505 seconds, and a "stabilized" phase of 867 seconds. The 1975 Federal Test Procedure consists of cold-start "transient" and "stabilized" phases, followed by a hot-start "transient." In this project, the hot-start "transient" was followed by a hot-start "stabilized." For the remainder of this discussion, and throughout this report, the four-cycle FTP will be identified as presented in Table 3.

TABLE 3. DESCRIPTION OF FOUR-CYCLE FTP

	Four-Cycle FTP			
	Cold UDDS		Hot UDDS	
Cycle	1	2	3	4
Duration, seconds	505	867	505	867
Regulated Emissions, 3-Bag	X	X	X	
Regulated Emissions, 4-Bag	X	X	X	X
Unregulated Emissions:				
Bag	X	X	X	X
Impinger (aldehydes, phenols)	---X---		---X---	
Filter (sulfate, metals, particulate)	---X---		---X---	
Trap (organic sulfides)	---X---		---X---	
Impinger (cyanide, ammonia, amines)	-------X-------			
Trap (nitrosamines)	-------X-------			

NOTE: X designates a sample taken

A composite value in mass per distance for the three-cycle, three sample FTP regulated emissions is calculated using the following formula:

$$\frac{\text{MASS}}{\text{DISTANCE}} = \frac{0.43\times(\text{MASS 1} + \text{MASS 2})}{(\text{DIST. 1} + \text{DIST. 2}} + \frac{0.57\times(\text{MASS 3} + \text{MASS 2})}{(\text{DIST. 3} + \text{DIST. 2})}$$

For the four-cycle FTP, two-sample composite values determined in this project, the following formula was used:

$$\frac{\text{MASS}}{\text{DISTANCE}} = \frac{0.43\times M(1 + 2)}{(D1 + D2)} + \frac{0.57\times M(3 + 4)}{(D3 + D4)}$$

For both the three- and four-cycle FTP's, actual measured distances are used for each cycle in the calculations.

To illustrate the similarity of the three- and four-cycle FTP's, the following assumptions are made. Since the same driving cycle is involved, Distance 3 is essentially equal to Distance 1, and Distance 4 is essentially equal to Distance 2, therefore, these equations can be reduced to:

$$\text{3-FTP M/D} \simeq \frac{0.43\times(M1 + M2) + 0.57\times(M3 + M2)}{D1 + D2}$$

$$\text{4-FTP M/D} \simeq \frac{0.43\times M(1 + 2) + 0.57\times M(3 + 4)}{D1 + D2}$$

Therefore, with the assumption that the changes in distance traveled are negligible, the composite results with the four-cycle FTP relative to results with the three-cycle FTP will differ only as the mass emissions emitted during Cycle 4 differ from those emitted during Cycle 2. For the regulated emissions, the differences during Cycles 2 and 4 were small, and the overall effects of such differences were essentially negligible.

The test sequence followed for each fuel is given in Table 4. The sequence followed in the laboratory for running one set of emissions tests (FTP and HFET) is given in Table 5. The sequence followed in the laboratory for running each multiple UDDS sequence is given in Table 6, and the sequence followed for running each multiple HFET sequence is given in Table 7.

The parameters of the two primary driving schedules are summarized in Table 8, and these schedules are illustrated in Figure 4. Other driving schedule designations frequently used are as follows:

Driving Schedule Designation Used	Other Common Designations
FTP	LA-4 and UDDS
HFET	FET

TABLE 4. TEST SEQUENCE FOR EACH FUEL EVALUATED

Sequence	Operation Performed with each Fuel
Upon Receipt	Drain and fill test vehicle with appropriate fuel, precondition with 2 UDDS
1	Run FTP, HFET - Sample and analyze emissions[a]
2	Run FTP - Sample and analyze emissions
3	Run multiple UDDS sequences (nine) - Sample with 20x20 Pallflex filters for soluble organic fraction analyses
4	Run multiple HFET sequences (eight) - Sample with 20x20 Pallflex filters for soluble organic fraction analyses

[a]Three FTP, HFET sequences were run for Fuel EM-338-F

TABLE 5. LABORATORY TEST SEQUENCE

1. Precondition, UDDS
2. Soak 12 to 20 hours
3. FTP - 4 bags for gaseous emissions
   2 filters or impinger samples*
4. Engine Off - 10 minutes - Fan Off
5. HFET - 1 bag sample
   1 filter or impinger sample

* 1 impinger or trap for some samples

NOTE: 5000 cfm fan on during all car operation. Additional tire and fuel tank cooling blowers on during all HFET operation.

TABLE 6. LABORATORY TEST SEQUENCE FOR MULTIPLE UDDS TESTS

1. Precondition, UDDS
2. Soak 12 to 20 hours
3. Cold Start UDDS
4. Engine Off - 10 minutes - Fan Off
5. Hot Start UDDS
6. Engine Off - 10 minutes - Fan Off
7. Repeat Steps 5 and 6
8. Repeat Steps 5 and 6
9. Repeat Steps 5 and 6
10. Force cooled cold start UDDS
11. Engine Off - 10 minutes - Fan Off
12. Repeat Steps 5 and 6
13. Repeat Steps 5 and 6
14. Repeat Steps 5 and 6

TABLE 7. LABORATORY TEST SEQUENCE FOR MULTIPLE HFET TESTS

1. Precondition, HFET
2. Engine off - 10-minutes - Fan Off - Load filters
3. HFET
4. Engine Off - 10-minutes - Fan Off
5. Repeat Steps 3 and 4
6. Repeat Steps 3 and 4
7. Repeat Steps 3 and 4
8. Repeat Steps 3 and 4
9. Repeat Steps 3 and 4
10. Repeat Steps 3 and 4
11. Repeat Step 3

TABLE 8. SUMMARY OF DRIVING SCHEDULE PARAMETERS

Schedule	Duration, Seconds	Distance, Kilometers	Average Speed km/hr	Average Speed mph
FTP:				
505	505	5.8	--	--
867	867	6.2	--	--
UDDS	1372	12.0	31.4	19.5
HFET	765	16.5	77.6	48.2

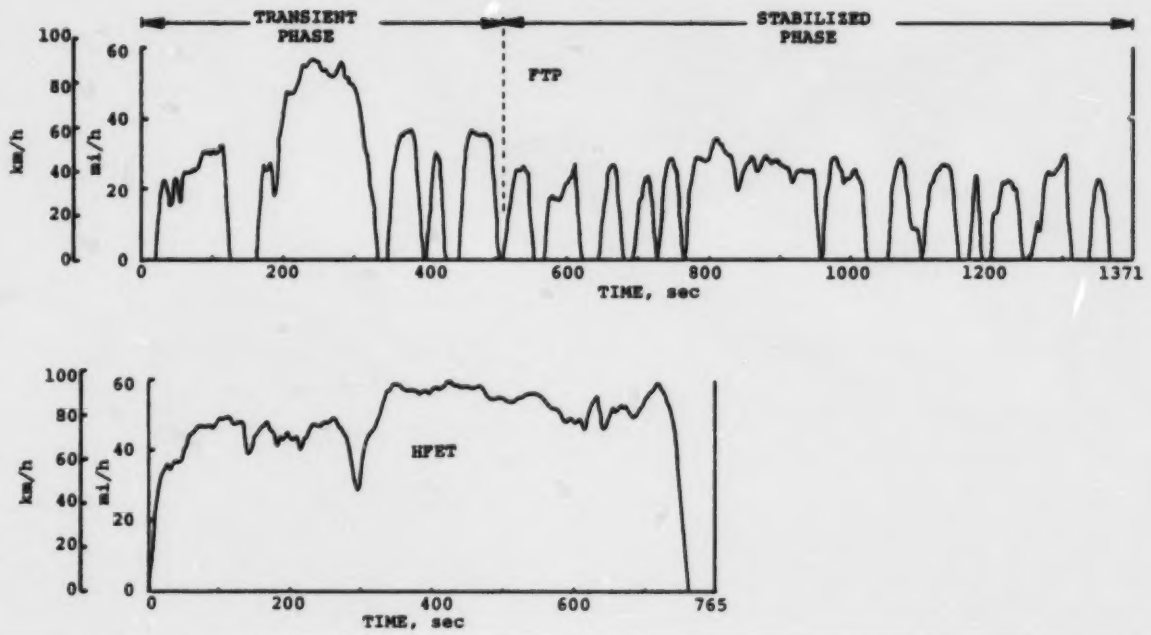


Figure 4. Driving cycle speed vs time traces

H. Test Numbering System

The numbering system used in this project consists of three digits plus a cycle abbreviation. The designation used for all automobile testing was

"VFD", followed by the individual test cycle abbreviation FTP or HFET. The meaning of each letter is described as follows:

Code	Description	As Used in This Project
V	Vehicle Designation	8
FD	Fuel Designation	51 thru 64

I. Computational Methods

The methods used for calculating the unregulated emissions results are given in Appendix A-3. All regulated emissions were calculated using the methods prescribed in the Code of Federal Regulations for Light-Duty Vehicles.(11) On the computer printouts for the regulated emissions (Appendix D), all items of potential interest are identified by descriptive headings. Items on the computer sheet identified only by abbreviated headings are used in calculating the unregulated emissions.

III. ANALYTICAL PROCEDURES FOR UNREGULATED EMISSIONS

The analytical procedures used to measure the unregulated emissions are summarized in this section. A detailed description of most of the procedures, along with the discussion of their development, validation, and qualification, is available in Interim Report II, "Analytical Procedures for Characterizing Unregulated Pollutant Emissions from Motor Vehicles," developed in a related EPA Project.(10)

A. Description of the Analytical Procedures

The unregulated emissions evaluated in this project, along with the methods for sampling and the procedures used in the analyses, are listed in Table 9. Organic amines, aldehydes and ketones, organic sulfides, individual hydrocarbons, metals and other elements, and phenols represent groups of compounds. The respective procedures separate and identify a number of individual compounds within each of these groups. The analytical procedures involved in this project are briefly described as follows:

Organic Amines - The collection of organic amines (monomethylamine, monoethylamine and dimethylamine, trimethylamine, diethylamine, and triethylamine) is accomplished by bubbling CVS-diluted exhaust through glass impingers containing dilute sulfuric acid. The amines are complexed by the acid to form stable sulfate salts which remain in solution. A portion of this solution is then injected into a gas chromatograph equipped with an ascarite loaded pre-column and a nitrogen-phosphorus detector (NPD). External amine standards in dilute sulfuric acid are used to quantify the results.

Ammonia - Ammonia in CVS-diluted automotive exhaust is measured in the protonated form, NH_4^+, after collection in dilute H_2SO_4. The acidification is carried out in a glass impinger maintained at ice bath temperature. A sample from the impinger is then analyzed for ammonia in an Ion Chromatograph and the concentration in the exhaust is calculated by comparison to an ammonium sulfate standard solution.

Aldehydes and Ketones - The collection of aldehydes (formaldehyde, acetaldehyde and hexanaldehyde) and ketones (acetone and methylethylketone) is accomplished by bubbling CVS-diluted exhaust through glass impingers containing 2,4-dinitrophenylhydrazine (DNPH) in dilute hydrochloric acid. The aldehydes and ketones (also known as carbonyl compounds) react with the DNPH to form their respective phenylhydrazone derivatives. These derivatives are insoluble or only slightly soluble in the DNPH/HCl solution and are removed by filtration followed by pentane extractions. The filtered precipitate and the pentane extracts are combined and then the pentane is evaporated in a vacuum oven. The remaining dried extract contains the phenylhydrazone derivatives. The extract is dissolved in a quantitative volume of toluene containing a known amount of anthracene as an internal standard. A portion of this dissolved extract is injected into a gas chromatograph and analyzed for several individual aldehydes and ketones, using a flame ionization detector.

TABLE 9. SAMPLING AND ANALYSIS METHODOLOGY FOR UNREGULATED EMISSIONS

Compound	Sampling	Method of Analysis
Organic Amines	Impinger	Gas chromatograph with ascarite pre-column and nitrogen-phosphorus detector (GC-NPD).
Ammonia (NH_3)	Impinger	Ion chromatograph.
Aldehydes & Ketones	Impinger	Dinitrophenylhydrazone derivative. Gas chromatograph with flame ionization detector (GC-FID).
Total Cyanide [Hydrogen Cyanide (HCN) and Cyanogen (C_2N_2)]	Impinger	Cyanogen chloride derivative. Gas chromatograph with electron capture detector (GC-ECD).
Carbonyl Sulfide (COS) and Organic Sulfides	Trap	Gas chromatograph with flame photometric detector (GC-FPD).
Individual Hydrocarbons	Bag	Gas chromatograph with flame ionization detector (GC-FID).
Metals and Other Elements	Filter	Weighed using microbalance. Spectral X-ray analysis at RTP.
Particulates	Filter	Weighed using microbalance.
Sulfate	Filter	Barium chloranilate derivative (BCA). Liquid chromatograph with ultraviolet detector.
Nitrosamines	Trap	Gas chromatograph with TEA detector.
Phenols	Impinger	Gas chromatograph with flame ionization detector (GC-FID).
BaP	Filter	Soxhlet extraction with methylene chloride. Liquid chromatograph with fluorescence detector.

Total Cyanide (Hydrogen Cyanide plus Cyanogen) - The collection of total cyanide is accomplished by bubbling CVS-diluted exhaust through glass impingers containing a 1.0 N potassium hydroxide absorbing solution. This solution is maintained at ice bath temperature. An aliquot of the absorbing reagent is then treated with KH_2PO_4 and Chloramine-T. A portion of the resulting cyanogen chloride is injected into a gas chromatograph equipped with an electron capture detector (ECD). External CN^- standards are used to quantify the results.

Carbonyl and Organic Sulfides - The collection of carbonyl sulfide (COS) and the organic sulfides, methyl sulfide (dimethysulfide, $(CH_3)_2S$), ethyl sulfide (diethylsulfide, $(C_2H_5)_2S$) and methyl disulfide (dimethyldisulfide, $(CH_3)_2S_2$), is accomplished by passing CVS-diluted exhaust through Tenax GC traps at -76°C. At this temperature the traps remove the organic sulfides from the dilute exhaust. The organic sulfides are thermally desorbed from the traps into a gas chromatograph sampling system and injected into a gas chromatograph equipped with a flame photometric detector for analysis. External organic sulfide standards generated from permeation tubes are used to quantify the results.

Individual Hydrocarbons - For measurement of the selected individual hydrocarbons, methane (CH_4), ethane (C_2H_6), ethylene (C_2H_4), acetylene (C_2H_2), propane (C_3H_8), propylene (C_3H_6), benzene (C_6H_6), and toluene (C_7H_8), a sample of CVS-diluted exhaust is collected in a Tedlar bag. This bagged sample is then analyzed for individual hydrocarbons using a gas chromatographic system containing four separate columns and a flame ionization detector. The peak areas are compared to an external calibration blend and the individual hydrocarbon concentrations are obtained using a Hewlett-Packard 3353 computer system.

Metals and Other Elements - The metals are collected as particulate on a 47 mm Fluoropore filter, which is then sent to Research Triangle Park (RTP) for analysis by X-ray spectroscopy. The diluted exhaust sample is taken from within the dilution tunnel. Weight gain on the filter is determined by weighing the filter on a microbalance before and after sampling.

Particulate - The particulate is collected on 47 mm Pallflex filters. The amount of "particulate" collected is determined by weighing the filter on a microbalance before and after sampling.

Sulfate - Automotive exhaust is vented into a dilution tunnel where it is mixed with a flowing stream of filtered room air. In the tunnel, the SO_3 reacts rapidly with water in the exhaust to form sulfuric acid aerosols. The aerosols grow to a filterable size range within the tunnel and are collected on a fluorocarbon membrane filter. Particulate sulfate salts are also collected on the filter.

Sulfuric acid collected on the filter is then converted to ammonium sulfate by exposure to ammonia vapor. The soluble sulfates are leached from a filter with a measured volume of an isopropyl alcohol - water solution (60% IPA). A fixed volume of the sample extract is injected into

a high pressure liquid chromatograph (HPLC) and pumped through a column of strong cation exchange resin in Ag^+ form to scrub out the halides (Cl^-, Br^-) and then through a column of strong cation exchange resin in H^+ form to scrub out the cations and convert the sulfate to sulfuric acid. Passage through a reactor column of barium chloranilate crystals precipitates out barium sulfate and releases the highly UV-absorbing chloranilate ions. The amount of chloranilate ions released is proportional to the sulfate in the sample and is measured by a sensitive liquid chromatograph UV detector at 310-313 nanometers. All the reactions and measurement take place in a flowing steam of 60% IPA. The scrubber and reactor columns also function as efficient filter media for any solid reaction products formed during passage of the sample through the column system.

Nitrosamines - The collection of nitrosamines (N-nitrosodimethylamine, N-nitrosodiethylamine, N-nitrosodipropylamine, N-nitrosodibutylamine, N-nitrosopiperidine, and N-nitrosopyrrolidine) is accomplished by passing CVS-diluted exhaust through ThermoSorb/N traps at a flow rate of 2 liters per minute. One sample is taken over several FTP test cycles to improve the detection limits. After sample collection, the ThermoSorb/N traps are sent to the Thermo Electron Corporation for analysis. At Thermo Electron the traps are backflushed with a 25/75 solution of methanol in dichloromethane. The first 1.5 to 1.8 mℓ of this eluant are saved for GC-TEA analysis. The GC-TEA instrument detection limits range from 5 ng for N-nitrosodimethylamine to 10 ng for N-nitrosodibutylamine. Additional information on the ThermoSorb/N traps and the GC-TEA analyzer can be found in the Task 2 Final Report of EPA Contract 68-03-2884, "Nitrosamines in Vehicle Interiors."[13]

Phenols - Phenols (phenol; salicylaldehyde; m-cresol/p-cresol; p-ethylphenol/2-isopropylphenol/ 2,3-xylenol/3,5-xylenol/2,4,6-trimethylphenol; 2,3,5-trimethylphenol; and 2,3,5,6-tetramethylphenol) in automotive exhaust are sampled and quantitatively analyzed with a gas chromatograph (GC) equipped with a flame ionization detector.[14] Dilute exhaust is passed through two Greenburg-Smith impingers in series, each containing 200 mℓ of 1 N KOH chilled in an ice bath. The contents of each impinger are acidified and extracted with ethyl ether. The samples are partially concentrated combined and then further concentrated to about 1 mℓ. An interal standard is added and the volume is adjusted to 2 mℓ. The final sample is analyzed by the use of the GC, and concentrations of individual phenols are determined by comparison to external and internal standards. The minimum detection limit is about 1 µg/mℓ.

Benzo(a)pyrene (BaP) - Benzo(a)pyrene is collected as particulate on 20"x20" Pallflex filters. The BaP is removed from the particulate by Soxhlet extraction with methylene chloride. The solvent is then evaporated and the sample is redissolved in acetonitrile for analysis. BaP is analyzed with the use of a HPLC system coupled to a fluorescence detector. The BaP collection and analytical method used at SwRI followed closely those used in General Motors Research Laboratories.[15]

B. Validation and Qualification of the Analytical Procedures

Several of the procedures used in this project were subjected to a series of validation and qualification experiments in previous projects. Validation experiments included checks for sample stability, sample collection efficiency, detector linearity, interferences, and analysis repeatability. Qualification experiments included the injection of the compound of interest into the dilution tunnel with and without the presence of exhaust and the subsequent recovery of that compound at the procedure sampling point.

Sample stability checks were performed using repeated analyses of the same sample at intervals over a specified period of time, and comparing the results to the initial analysis. Organic amines, aldehydes and ketones, ammonia, total cyanide, phenols and individual hydrocarbon samples were found to be stable for several days. Carbonyl and organic sulfides samples were found to be stable for approximately one day.

Sample collection efficiency experiments were performed by passing a known concentration of sample through a series of impingers or traps and analyzing each impinger or trap individually for the compound of interest. All of these procedures used in this project had a collection efficiency of 98% or better. Detector linearity experiments were performed by preparing several samples of various known concentrations and plotting the resulting peak areas versus the concentrations. The procedures had linear response over the range of interest in this project.

To determine interferences from other compounds, for each procedure, known exhaust components were introduced into the sample to determine their effect on the resultant measurements. To determine analysis repeatability, several samples of known concentrations were prepared and a number of complete analyses were performed at each concentration. The results of these tests were then compared to determine analysis repeatability.

The qualification experiments were performed to determine if the compounds of interest could travel the length of the dilution tunnel in the presence of dilute exhaust without significant loss by reaction with exhaust or the tunnel itself. The compounds were introduced where the exhaust enters the tunnel and were sampled at the normal sampling point. Table 10 lists the procedures for which validation and qualification experiments have been performed.

C. Accuracy of the Analytical Procedures

A difficult, but very important endeavor was the determination of procedural accuracy for each analytical method. The primary difficulty involved those procedures in which the exhaust compounds are trapped or absorbed, an extraction or subsequent reaction is performed, and then a portion of the extract is analyzed. After much consideration, in previous unregulated emission projects, the decision was reached to initially define the accuracy in terms of a "minimum detection value" (MDV). The MDV, as

TABLE 10. PROCEDURAL VALIDATION AND QUALIFICATION

Compound or Compound Group	Validation Conducted	Qualification Conducted
Organic Amines	Yes	Yes (significant tunnel losses)
Ammonia	Yes	Yes (significant tunnel losses)
Aldehydes & Ketones	Yes	Yes
Total Cyanide	Yes	Yes
Carbonyl Sulfide and Organic Sulfides	Yes	Yes (significant tunnel losses)
Individual Hydrocarbons	Yes	No[a]
Metals and Other Elements	No[a]	No[a]
Particulates	No[a]	No[a]
Sulfate	No[a]	No[a]
Nitrosamines	No[a]	No[a]
Phenols	Yes	Yes
BaP	No[a]	No

[a]Established procedure

used in this report, is defined as the value above which it can be said that the compound has been detected in the exhaust (i.e., at a measured value equal to the MDV, the accuracy is equal to plus or minus the MDV). Determination of accuracy over the entire range of each procedure was beyond the scope of these projects.

For compounds collected by bag samples, the MDV was determined from the instrument detection limits only, and is independent of the sampling rate and duration. For compounds which are concentrated in impingers or traps, the MDV is dependent on the instrument detection limit, chemical workup, sampling rate and sampling duration. The MDV's listed in Table 11 were derived using the listed sampling rate and a 23-minute sampling period.

TABLE 11. EMISSION PROCEDURAL SAMPLE RATES AND ACCURACY

		Mol. Weight	Sample Flow ℓ/min	µg/m³ per ppm	Procedural Minimum Detection Values[a] ppm	µg/m³	MDV for FTP[b] mg/km
Test Number,	VFD	--	--	--	--	--	--
Barometer,	mm Hg	--	--	--	--	--	--
Humidity,	g/kg	--	--	--	--	--	--
Temperature,	°C	--	--	--	--	--	--
Carbon Dioxide,	g/km	44.01	Bag	--	--	--	--
Fuel Cons.,	ℓ/100 km	--	--	--	--	--	--
Regulated Emissions							
Hydrocarbons (THC)		11.88	Bag	575	1.0[c]	575	10
Carbon Monoxide		28.01	Bag	1165	2.0[c]	2330	40
Oxides of Nitrogen		46.01	Bag	1915	0.5[c]	958	16
Particulates							
Total Particulates		--	14.0	--		<50	<1
Sulfate		96.01	14.0	4000	<0.01	6	0.1
Compound Group Totals							
Aldehydes & Ketones		--	4.0	--	--	--	≃0.5
Individual Hydrocarbons		--	Bag	--	--	--	≃0.5
Organic Sulfides		--	0.13	--	--	--	≃0.05
Organic Amines		--	4.0	--	--	--	≃0.1
Phenols		--	22.0	--	--	--	≃0.8
Nitrosamines		--	2.0	--	--	--	<0.001
Other Compounds							
Ammonia		17.03	4.0	710	0.01	7	0.1
Cyanide & Cyanogen		26.02	4.0	1080	0.01	11	0.2

[a] Based on a 23-minute sampling period at the specified flow rate for all impinger, filter and trap collected samples.

[b] Based on µg/m³ in the diluted exhaust and typical UDDS (FTP 505 and 867) parameters (1372 seconds, 206 m³ CVS flow, 12.07 km, 0.98 DSFC) mg/km for FTP ≃ µg/m³ × 206 ÷ 12.07 × 0.98 × 0.001 ≃ 0.0168 × µg/m³.

[c] Based on the lowest instrument ranges used in this project.

TABLE 11 (Cont'd). EMISSION PROCEDURAL SAMPLE RATES AND ACCURACY

	Mol. Weight	CRC[d] Synonym	$\mu g/m^3$ per ppm	Procedural Minimum Detection Values[a] ppm	$\mu g/m^3$	MDV for FTP,[b] mg/km
Aldehydes and Ketones						
Formaldehyde	30.03	--	1250	0.01	15	0.2
Acetaldehyde	44.05	--	1830	0.01	20	0.3
Acetone[e]	58.08	2-Propanone	2415	0.01	25	0.4
Methylethylketone	72.12	2-Butanone	3000	0.01	30	0.5
Hexanaldehyde	100.16	Hexanal	4165	0.01	40	0.7
Individual Hydrocarbons						
Methane	16.04	--	665	0.05	30	0.5
Ethylene	28.05	Ethene	1165	0.03	30	0.5
Ethane	30.07	--	1250	0.03	30	0.5
Acetylene	26.04	Ethyne	1085	0.03	30	0.5
Propane	44.11	--	1835	0.02	30	0.5
Propylene	42.08	Propene	1750	0.02	30	0.5
Benzene	78.12	--	3245	0.02	30	0.5
Toluene	92.15	--	3830	0.02	30	0.5
Organic Sulfides						
Carbonyl Sulfide	60.08	--	2500	0.001	3	0.04
Methyl Sulfide	62.13	Dimethyl	2585	0.001	3	0.04
Ethyl Sulfide	90.19	Diethyl	3750	0.001	4	0.06
Methyl Disulfide	94.20	Dimethyl	3915	0.001	4	0.06
Organic Amines						
Monomethylamine	31.06	Amino-Methane	1290	0.002	3	0.05
Monoethylamine[f]	45.09	Amino-Ethane	1875	0.002	4	0.05
Trimethylamine	59.11	--	2460	0.002	5	0.08
Diethylamine	73.14	--	3040	0.002	6	0.10
Triethylamine	101.19	--	4205	0.002	8	0.14
Phenols						
Phenol	94.11	--	3915	0.014	55	0.92
Salicyaldehyde	122.13	--	5080	0.013	65	1.09
m- and p-cresol	108.15	--	4500	0.010	45	0.76
Five[g]	g	--	5315	0.021	110	1.85
2-n-propylphenol	136.20	--	5665	0.006	35	0.59
2,3,5 trimethylphenol	136.20	--	5665	0.004	20	0.34
2,3,5,6 tetramethylphenol	155.22	--	6250	0.002	10	0.17

[a] & [b] See initial page of this table.
[d] Handbook of Chemistry and Physics, 54th Edition.
[e] Includes Acrolein - 56.07 and Propionaldehyde - 58.08 (CRC - Propenal and Propanal, respectively).
[f] Includes Dimethylamine - 45.09
[g] Includes p-ethylphenol - 122.17; 2-isopropylphenol - 136.20; 2, 3-xylenol - 122.17; 3,5-xylenol - 122.17; 2,4,6-trimethylphenol - 136.20.

IV. VEHICLE TESTING

Regulated and unregulated exhaust emissions were evaluated for a 1981 Volkswagen Rabbit operating on five alternate source fuels and on Amoco Indolene as a base fuel.

A. Vehicle - Fuel Evaluations

The vehicle - fuel evaluations conducted in this program are listed in Table 12 along with the number and types of emission tests performed. In general, each fuel was evaluated over duplicate FTP and single HFET test cycles. The base fuel, EM-338-F, however, was evaluated over four FTP and HFET tests, three FTP and HFET tests in November 1981 and one FTP and HFET test in February 1983. The tests in November 1981 were run in conjunction with another EPA program, Task Specifications 11 and 12 of Contract 68-03-2884, which monitored similar emissions for fuel EM-338-F. The Simulated Coal gasoline, the Mobil MTG gasoline, and the EDS Naphtha gasoline blend were evaluated in subsequent months in early 1982. Due to the lack of available test fuels, no additional testing was conducted for this program until February 1983, when the Sasol and H-Coal Naphtha gasoline blends became available for testing. Before emission tests were conducted with the Sasol and H-Coal Naphtha blends, the Volkswagen Rabbit was rerun with the base fuel in February 1983 (only regulated gaseous and particulate emission were sampled). Table 13 lists the average emissions and fuel consumption values for the baseline tests conducted in November 1981, along with the values obtained during February 1983. As can be seen in the Table, the February 1983 baseline fuel consumption rate decreased approximately 8 percent from the November 1981 values. During the time between testing in early 1982 and the baseline tests in February 1983, the test vehicle was "malfunctioned" (rich base idle - disconnected oxygen sensor) and run at idle and low speed conditions in

TABLE 13. BASELINE EMISSIONS AND FUEL CONSUMPTION

	Feb. 1983	Nov. 1981
	FTP	
HC, g/km	0.08	0.07
CO, g/km	0.76	0.67
NO_x, g/km	0.24	0.10
Fuel Cons., ℓ/100km	9.10	9.90
Particulates, mg/km	14.66	7.30
	HFET	
HC, g/km	0.06	0.07
CO, g/km	0.45	0.78
NO_x, g/km	0.08	0.04
Fuel Cons., ℓ/100 km	7.14	7.73
Particulates, mg/km	9.81	19.96

TABLE 12. PROJECT TEST MATRIX

FTP Tests Conducted

Emissions Characterized	Fuel: Base EM-338-F	Mobil MTG EM-486-F	Simulated Coal EM-468-F	EDS Naphtha Blend EM-488-F	Unleaded Sasol Blend EM-542-F	H-Coal Naphtha Blend EM-543-F
Regulated Gaseous, Fuel Cons.	4	2	2	2	2	2
Individual Hydrocarbons	3	2	2	2	2	2
Aldehydes	3	2	2	2	2	2
Phenols	1			1		
Particualte Mass	4	2	2	2	2	2
Sulfate	2	1		1	1	1
Metals and Other Elements	1	1	1	1	1	1
Organic Sulfides	2			1		1
Ammonia	2	1		1	1	1
Cyanide	2			1[a]	1	1[a]
Organic Amines	2			--		--
Nitrosamines	1			1		
Particulate Organic Soluble Fraction	1		1	1	1[b]	1[b]
C,H,N,O Composition of Organic Solubles	1		1	1	--	--
Benzo(a)pyrene in Organic Solubles	1		1	1	1	1

HFET Tests Conducted

	Fuel: Base EM-338-F	Mobil MTG EM-486-F	Simulated Coal EM-468-F	EDS Blend EM-488-F	Unleaded Sasol Blend EM-542-F	H-Coal Naphtha Blend EM-543-F
Regulated Gaseous, Fuel Cons.	4	1	1	1	1	1
Individual Hydrocarbons	3	1	1	1	1	1
Aldehydes	3	1	1	1	1	1
Phenols	1			1		
Particulate Mass	4	1	1	1	1	1
Sulfate	2	1		1	1	1
Metals and Other Elements	1	1	1	1	1	1
Particulate Organic Sol. Frac.	1	1	1	1	1[b]	1[b]
C,H,N,O Comp of Org. Sol.	1	1	1	1	--	--
Benzo(a)pyrene in Org. Sol.	1	1	1	1	1	1

[a] Sample collected-no data due to instrument malfunction
[b] Sample collected-sample lost in transit for analysis

yet another EPA contract, Work Assignment 4 of EPA Contract 68-03-3073. Following emission testing in this program the vehicle was returned to manufacturer's specifications. It appears that, as a result of these adjustments, the vehicle was running slightly leaner in February 1983 than in November 1981 (HFET decrease in CO and increase in NO_x). However, it must be noted that the 8 percent deviation in fuel consumption from the November 1981 tests to the February 1983 tests is only 4 1/2 percent more than the test-to-test variations in fuel consumption experienced in November 1981. The unleaded Sasol gasoline and the H-Coal Naphtha blends were evaluated in the months following the February 1983 baseline testing.

As can be seen in Table 12, only selected unregulated emissions were evaluated for each fuel. The emissions selected were based on emission results obtained from previous EPA unregulated emission programs and on individual fuel properties. Multiple UDDS (nine) and HFET (eight) tests were run to generate single FTP and HFET particulate samples for subsequent extraction to determine soluble organic fraction of particulate, major element composition of extract (carbon, hydrogen, oxygen, and nitrogen) and benzo(a)pyrene emissions. An attempt was made to collect particulate on glass fiber filters for particulate carbon and hydrogen analyses; however, due to the low particulate emission rates and the fragile nature of the glass fiber filters, very low, and in several cases, apparent negative particulate weights were obtained. Because of these problems, it was not possible to obtain suitable samples for the carbon and hydrogen analyses.

B. Regulated and Unregulated Emission Test Results

Summaries of the test results are included in Appendix B. Individual sample data for the FTP evaluations are included in Appendix C and the computer printouts for the regulated emissions are included in Appendix D. The analyses and discussion of these test results are included in Section V of this report. Aldehydes & ketones, individual hydrocarbons, organic sulfides, phenols, particulates, sulfate, and metals emissions data are based on appropriately weighted four-cycle FTP results. Cyanide, ammonia, amines, and nitrosamines emissions data are based on unweighted four-cycle FTP results (i.e., one sample taken over an entire four-cycle test for the cyanide, ammonia, and amines, and one sample taken over two or three four-cycle tests for the nitrosamines.)

In these data tables, a double dash (--) has been used when no test data were available. This occurs for the unregulated emissions when valid test data could not be obtained due to instrument malfunction or loss of the sample. Blanks are left in the tables where the analyses were excluded in accordance with the program scope of work.

C. Large Filter Sampling and Results

As described in Section II-F and Tables 6 and 7 of this report, 20 inch by 20 inch Pallflex filters were used to collect particulate for extraction

and subsequent analyses. The Volkswagen Rabbit was operated over multiple UDDS (nine) and HFET (eight) test cycles with the six test fuels to generate the particulate. The soluble organic fraction of the particulate was removed by Soxhlet extraction procedures (16) using methylene chloride as an extracting solvent. Particulate and extractable organic data for the six test fuels are listed in Table 14. The Sasol and H-coal Naphtha gasoline blends gave the largest amounts of particulate for both the UDDS and HFET cycles. Both these fuels, however, had a low percentage of organic extractables. Because of these low percentages for the Sasol and H-Coal Naphtha blends, all six fuels gave approximately the same emission levels of organic extractables (0.38 to 0.72 mg extract/km) for both the UDDS and the HFET test cycles.

The organic extracts from the multiple UDDS and HFET cycles were analyzed for benzo(a)pyrene and for major elemental composition (carbon, hydrogen, nitrogen, and oxygen). Table 15 lists the results of the benzo-(a)pyrene and major element analyses. The elemental analysis samples for the Sasol and H-Coal Naphtha blends were lost in transit to Galbraith Laboratories for analysis, therefore, no such data are available for these fuels. Of the six fuels, the Simulated Coal gasoline gave the highest levels of benzo(a)pyrene, while the base fuel gave the lowest levels. Of the fuel extracts analyzed for major elements, the Mobil MTG gasoline extract gave the highest levels of elemental nitrogen and oxygen.

TABLE 14. PARTICULATE AND ORGANIC EXTRACTABLES FROM LARGE FILTER SAMPLING

Fuel	Particulate		Extractable Organics	
	Sample Weight, mg	Vehicle Emission Rate, mg/km	Percent of Particulate	Vehicle Emission Rate, mg/km
Multiple UDDS Cycles				
Base Fuel	211	1.95	19	0.38
Mobil MTG	157	1.45	32	0.47
Simulated Coal Fuel	454	4.20	17	0.72
EDS Naphtha Blend	214	1.98	21	0.43
Sasol Blend	3583	33.18	1	0.48
H-Coal Naphtha Blend	1034	9.57	5	0.44
Multiple HFET Cycles				
Base Fuel	221	1.67	23	0.39
Mobil MTG	211	1.60	31	0.49
Simulated Coal Fuel	396	3.00	13	0.40
EDS Naphtha Blend	286	2.17	20	0.42
Sasol Blend	6212	47.06	1	0.32
H-Coal Naphtha Blend	1469	11.03	4	0.40

TABLE 15. BENZO(a)PYRENE AND MAJOR ELEMENTS IN ORGANIC SOLUBLES FROM PARTICULATE MATTER

	Benzo(a)pyrene µg/km	Weight Percent Elements in Organic Solubles				
		Carbon	Hydrogen	Nitrogen	Oxygen	ΣCHNO
Multiple UDDS CYCLES						
Base Fuel	0.018	81.35	12.42	1.15	4.75	99.67
Mobil MTG	0.091	76.55	11.70	2.08	7.53	97.86
Simulated Coal Fuel	0.118	80.68	12.49	1.26	4.29	98.72
EDS Naphtha Blend	0.119	80.42	12.61	0.54	6.03	99.60
Sasol Blend	0.051	--[a]	--	--	--	--
H-Coal Naphtha Blend	0.076	--	--	--	--	--
Multiple HFET Cycles						
Base Fuel	0.056	82.41	12.99	1.22	3.18	99.80
Mobil MTG	0.076	74.09	10.89	2.39	12.55	99.92
Simulated Coal Fuel	0.119	81.74	12.19	1.18	2.87	97.98
EDS Naphtha Blend	0.082	80.90	12.20	1.07	2.84	97.01
Sasol Blend	0.026	--[a]	--	--	--	--
H-Coal Naphtha Blend	0.045	--	--	--	--	--

[a]Samples lost in transit to Galbraith Laboratories for analysis

V. ANALYSES OF THE RESULTS

This section reports the analysis performed on the emissions data generated in this project. The analysis involved averaging and reformatting the data to enable making various comparisons. Due to the very limited number of data points for each pollutant at each specific condition, advanced statistical analyses were judged to be inapplicable.

A. Regulated Emissions and Fuel Consumption

The initial analysis of the data involved averaging the results for the duplicate or triplicate emission tests. These averages are included with the individual test data in Appendix B. A summary of the average regulated emissions and fuel consumption data is presented in Table 16.

TABLE 16. SUMMARY OF THE AVERAGE REGULATED EMISSIONS AND FUEL CONSUMPTION DATA

	FTP			
	HC (g/km)	CO (g/km)	NO_x (g/km)	Fuel Cons. (ℓ/100km)
Base Fuel, EM-338-F (Nov., 1981)	0.07	0.67	0.10	9.90
Mobil MTG, EM-486-F	0.06	0.69	0.15	9.74
Simulated Coal Fuel, EM-468-F	0.07	0.35	0.14	9.24
EDS Naphtha Blend, EM-488-F	0.08	0.78	0.18	9.64
Base Fuel, EM-338-F (Feb., 1983)	0.08	0.86	0.24	9.10
Sasol Blend, EM-542-F	0.15	0.93	0.53	9.20
H-Coal Naphtha Blend, EM-543-F	0.13	1.47	0.47	9.34
1981 Federal Emissions Std.	0.25	2.11	0.62	

	HFET			
	HC (g/km)	CO (g/km)	NO_x (g/km)	Fuel Cons. (ℓ/100km)
Base Fuel, EM-338-F (Nov., 1981)	0.07	0.78	0.04	7.73
Mobil MTG, EM-486-F	0.03	0.43	0.05	7.63
Simulated Coal Fuel, EM-468-F	0.04	0.62	0.08	7.66
EDS Naphtha Blend, EM-488-F	0.08	1.56	0.10	7.28
Base Fuel, EM-338-F (Feb., 1983)	0.08	0.45	0.08	7.14
Sasol Blend, EM-542-F	0.07	0.42	0.18	7.00
H-Coal Naphtha Blend, EM-543-F	0.06	0.84	0.25	6.92

To enable comparisons with the baseline fuel, the results for the Mobil MTG, the Simulated Coal Fuel and the EDS Naphtha blend fuel (which were tested in early 1982) are grouped with the November 1981 baseline test results; while the results for the Sasol and H-Coal Naphtha blends (which were

tested in early 1983) are grouped with the February 1983 baseline test results. The 1981 Federal Emission Standards for HC, CO, and NO_x have also been included in the table for comparison. As can be seen in the table, all six fuels gave emissions which met the 1981 standards.

All five alternate fuels gave higher NO_x emission rates than the base fuel for both the FTP and the HFET test cycles, with the Sasol and the H-Coal Naphtha blends giving the highest NO_x emission rates. It must be noted however, that the NO_x emission rates appeared to increase with time, with each subsequent test series giving equivalent or slightly higher emission rates than the previous test series regardless of fuel type. Therefore, the possibility exists that the increase in NO_x emissions may have been due to a slight but constant drift in the feedback control system of the vehicle and not due to fuel properties.

With the exception of the FTP Simulated Coal Fuel tests and the HFET EDS Naphtha blend test, the alternate fuels had fuel consumption rates that did not vary more than three percent from the corresponding baseline rates. Three percent is a nominal value for test-to-test repeatability using the same test fuel. The lower fuel consumption rate for the FTP Simulated Coal Fuel tests (7 percent lower than the baseline tests) may be due to its higher density (highest of the six fuels, Table 17) and higher percentage carbon in the fuel (also highest of the six fuels), as the actual densities and carbon percentages were used in the carbon balance method for determining fuel consumption. While the EDS Naphtha blend also has a higher density than the base fuel, it does not have a corresponding higher percentage of carbon in the fuel. The lower HFET fuel consumption (6 percent lower than the base fuel) may be due to the lack of multiple test points for comparison as only one HFET test was run for each alternate fuel.

Both Naphtha blends (EDS and H-Coal) gave higher carbon monoxide emissions than the base fuel for both the FTP and HFET test cycles, while

TABLE 17. FUEL DENSITIES AND CARBON PERCENTAGES FOR THE SIX FUELS

	Density g/mℓ	Percent Carbon
Base Fuel	0.737	85.66
Mobil, MTG	0.744	86.42
Simulated Coal Fuel	0.764	87.23
EDS Naphtha Blend	0.756	85.11
Sasol Blend	0.729	85.77
H-Coal Naphtha Blend	0.763	85.47

the Simulated Coal gasoline gave lower carbon monoxide emissions than the base fuel for both cycles. The Mobil MTG gasoline gave lower carbon monoxide emissions for the HFET cycle only. The emissions for the Sasol blend (FTP and HFET) and the Mobil MTG gasoline (FTP) were within 10 percent of the baseline results. The Sasol and H-Coal Naphtha blends gave hydrocarbon emissions significantly higher than the base fuel for the FTP cycle (88 and 63

percent respectively), but their HFET hydrocarbon emissions were similar to the base fuel. The reverse was true for the Mobil MTG and the Simulated Coal gasolines, which gave FTP emissions similar to the base fuel and HFET emissions lower than the base fuel.

B. Individual Hydrocarbon Emissions Data

The emissions of eight individual hydrocarbons (IHC); methane, ethylene, ethane, acetylene, propane, propylene, benzene, and toluene; were measured in this project. Table 18 lists the FTP and HFET emissions for the eight compounds. The IHC emissions in general parallel the total hydrocarbon emissions found in Table 16. The base fuel, the EDS Naphtha blend, the Sasol Blend and the H-Coal Naphtha Blend all gave similar HFET IHC emissions, while the Mobil MTG and the Simulated Coal gasolines had HFET methane, ethylene, ethane, propylene, and toluene emissions that were lower than the other four fuels. The Sasol and H-Coal Naphtha blends had the highest FTP methane, ethylene, ethane, propylene, and toluene emissions of the six fuels tested. The EDS Naphtha blend also had high FTP methane emissions with respect to the base fuel, however the emissions for the remaining seven IHC compounds were similar to the base fuel.

C. Aldehyde and Ketone, Particulate, Sulfate, Ammonia, and Cyanide Emissions

Aldehydes and ketones, and particulate emissions were determined for both the FTP and HFET test cycles for all six fuels. Sulfate was monitored for both the FTP and HFET test cycles for all fuels except the Simulated Coal gasoline. Ammonia and cyanide emissions were evaluated only for selected fuels over the FTP test cycle. The results of these evaluations are included in Table 19.

Fuel nitrogen content appears to have had little effect on the FTP ammonia and cyanide emissions from the EDS and H-Coal Naphtha Blends, which both have high fuel nitrogen content as compared to the other fuels (115 and 727 ppm respectively versus less than 10 ppm for the other fuels). The EDS and H-coal Naphtha Blends gave FTP ammonia and cyanide emissions equal to or lower than the other test fuels. The ammonia and cyanide emissions are similar to those obtained in previous EPA programs for properly tuned 3-way catalyst equipped vehicles,[3,4,6,7] approximately 20 mg/km for ammonia and less than 1 mg/km for cyanide.

Fuel sulfur content also appears to have had little effect on the sulfate emissions. Both the EDS and H-Coal Naphtha blends have sulfur concentrations 10 times higher than the base fuel, however, only minor differences occur in both the FTP and HFET sulfate emission rates. Both the FTP and HFET sulfate emissions are typical of 3-way catalyst equipped vehicles.[3,4,6,7]

The various fuels tested in this program gave little or no aldehyde and ketone emissions differences. Of the five aldehydes and ketones analyzed for, only methyethylketone and acetaldehyde were detected in the exhaust. Methylethylketone was detected only in the MTG gasoline tests and acetaldehyde was detected only in the Sasol blend tests. Low aldehyde and ketone emissions are typical of late model 3-way catalyst equipped vehicles.[3,4,6,7]

TABLE 18. SUMMARY OF THE AVERAGE INDIVIDUAL HYDROCARBON DATA

	Methane	Ethylene	Ethane	Acetylene	Propane	Propylene	Benzene	Toluene
	FTP Emissions, mg/km							
Base Fuel	8.70	3.00	1.59	1.08	0.00	2.62	3.30	5.73
Mobil MTG	7.93	3.02	0.88	1.22	0.14	1.76	1.34	0.57
Simulated Coal Fuel	6.33	3.93	1.13	1.37	0.00	1.91	3.23	5.58
EDS Naphtha Blend	16.60	3.49	2.78	1.08	0.00	2.50	2.15	4.09
Sasol Blend	23.18	7.43	6.87	0.92	0.11	5.24	3.97	7.06
H-Coal Naphtha Blend	21.92	6.04	4.29	1.02	0.16	3.13	3.44	5.77
	HFET Emissions, mg/km							
Base Fuel	17.07	2.58	3.89	0.00	0.00	3.21	6.41	4.61
Mobil MTG	6.93	0.92	1.38	0.00	0.00	0.00	3.89	0.00
Simulated Coal Fuel	8.21	2.01	2.16	0.00	0.00	0.00	5.36	0.00
EDS Naphtha Blend	18.96	3.95	4.98	0.00	0.00	2.39	4.70	3.94
Sasol Blend	14.73	3.55	3.00	0.00	0.00	3.63	3.15	2.14
H-Coal Naphtha Blend	15.22	2.81	3.10	0.00	0.00	0.00	3.02	1.43

TABLE 19. SUMMARY OF PARTICULATE, SULFATE, AMMONIA, CYANIDE, AND ALDEHYDE AND KETONE EMISSIONS

Fuel	Particulates	Sulfate	Ammonia	Cyanide	Total Aldehydes and Ketones
	FTP Emissions, mg/km				
Base Fuel	7.30	0.41	17.00	0.02	0.00
Mobil MTG	3.27	0.44	11.18	[a]	0.09
Simulated Coal Fuel	3.92				0.00
EDS Naphtha Blend	2.00	0.65	1.15	0.27	0.00
Sasol Blend	35.26	0.52	10.43	0.32	0.01
H-Coal Naphtha Blend	24.23	0.70	14.24	0.06	0.00
	HFET Emissions, mg/km				
Base Fuel	19.96	1.58			0.00
Mobil MTG	2.73	0.55			0.83
Simulated Coal Fuel	4.49				0.00
EDS Naphtha Blend	3.19	0.52			0.00
Sasol Blend	94.22	0.40			0.00
H-Coal Naphtha Blend	26.09	1.78			0.00

[a] Blanks appear in the table where analyses were excluded in accordance with the program scope of work.

Particulate emissions varied considerably for the six fuels, with the Sasol blend having both the highest FTP and HFET emissions, followed by the H-Coal Naphtha blend. Three-way catalyst equipped vehicles normally have FTP particulate emissions on the order of 9 mg/km.[7] With the exception of the Sasol and H-Coal Naphtha blends, the fuels tested in this program gave particulate emissions equivalent to or lower than this value. The Sasol blend originally contained lead, which was subsequently removed for testing in this program. This lead removal process, however, did not remove the halogens, chlorine and bromine, which are normally associated with leaded fuel. Trace element analyses (discussed in the following subsection) indicated approximately 65 percent of the particulate in the FTP cycle and 80 percent of the particulate in the HFET cycle consisted of chlorine and bromine for the Sasol blend fuel. Substantial amounts of chlorine and bromine were also found in the particulate from the H-Coal Naphtha blend, indicating the possibility of carry-over from the previously-tested Sasol fuel. If the bromine and chlorine are disregarded, then the particulate mass emissions for the Sasol and H-Coal blends are similar to the remaining fuels.

D. Trace Element Emissions

Trace element analyses were conducted on particulate collected during testing of the six fuels. Each filter was analyzed for a total of thirty-one elements by x-ray fluorescence. Vanadium, nickel, cadmium, tin, potassium, antimony, selenium, titanium, cobalt, and platinum were analyzed for, but were not detected above 0.02 mg/km for any filter analyzed in the program. Sodium, mercury, magnesium, chrominum, copper, lead, manganese, silicon, tungsten, arsenic, and bromine were detected only in the particulate from the Sasol and/or the H-Coal Naphtha blends. The emissions for these elements are listed in Table 20.

The remaining ten elements (sulfur, chlorine, aluminum, zinc, calcium, iron, barium, phosphorus, strontium, and molybdenum) were, for the most part, detected in the particulate from all six test fuels. The emissions for these ten elements are summarized in Table 21.

As discussed in the previous section, the Sasol blend contained chlorine and bromine, which were detected in the particulate at levels much higher than those for the other test fuels. The H-Coal Naphtha blend particulate also contained bromine and chlorine, but at levels significantly lower than the Sasol blend, indicating the possibility of carry-over from the previously-tested Sasol blend. These elements may have originated from the H-Coal Naphtha blend, however, because low levels of lead were also detected in the particulate. The Sasol blend particulate contained only 0.02 mg/km of lead for the HFET cycle and only 0.02 mg/km of tin for the FTP cycles, indicating the successful removal of the lead from the leaded Sasol fuel and the near-absence of tin (which was used in the lead removal process).

There is no other apparent relationship of the trace elements in the particulate to the test fuels except for the larger number and slightly higher levels of trace elements in the particulate from the Sasol and H-Coal Naphtha blends. As was the case for the sulfate emissions, there is no apparent relationship between the particulate sulfur emission levels and the sulfur content in the fuel.

TABLE 20. TRACE ELEMENT EMISSIONS - SASOL AND H-COAL NAPHTHA BLENDS ONLY

	FTP Emissions, mg/km		HFET Emissions, mg/km	
	Sasol Blend	H-Coal Naphtha Blend	Sasol Blend	H-Coal Naphtha Blend
Sodium	0.01	0.02	0.11	0.05
Mercury	0.00	0.02	0.01	0.06
Magnesium	0.01	0.01	0.03	0.01
Chromium	0.00	0.02	0.00	0.04
Copper	0.01	0.03	0.01	0.02
Lead	0.00	0.65	0.02	0.46
Manganese	0.03	0.01	0.02	0.01
Tungsten	0.00	0.00	0.04	0.00
Silicon	0.02	0.04	0.02	0.01
Arsenic	0.04	0.01	0.05	0.00
Bromine	0.96	0.33	10.94	2.27

TABLE 21. TRACE ELEMENT EMISSIONS - ALL FUELS

	FTP Emissions, mg/km					
	Base Fuel	Mobil MTG	Simulated Coal	EDS Naphtha Blend	Sasol Blend	H-Coal Naphtha Blend
Sulfur	0.03	0.01	0.01	0.04	0.15	0.26
Chlorine	0.02	0.00	0.28	0.05	22.23	2.05
Aluminum	0.10	0.01	0.01	0.02	0.21	0.14
Zinc	0.03	0.02	0.02	0.03	0.02	0.08
Calcium	0.08	0.05	0.07	0.11	0.13	0.16
Iron	0.91	0.07	0.09	0.17	3.28	2.19
Barium	0.05	0.03	0.04	0.07	0.07	0.10
Phosphorus	0.02	0.01	0.01	0.04	0.05	0.07
Strontium	0.33	0.24	0.15	0.00	0.04	0.11
Molybdenum	0.56	0.39	0.29	0.00	0.06	0.18
	HFET Emissions, mg/km					
Sulfur	0.07	0.01	0.01	0.03	0.16	0.36
Chlorine	0.41	0.01	0.51	0.19	64.81	8.49
Aluminum	0.03	0.01	0.01	0.01	0.19	0.07
Zinc	0.00	0.00	0.04	0.03	0.04	0.05
Calcium	0.03	0.04	0.05	0.07	0.11	0.10
Iron	0.27	0.03	0.04	0.15	2.56	1.09
Barium	0.02	0.02	0.03	0.04	0.07	0.06
Phosphorum	0.00	0.01	0.01	0.02	0.04	0.04
Strontium	0.26	0.00	0.00	0.00	0.14	0.05
Molybdenum	0.48	0.00	0.00	0.00	0.16	0.00

E. Other Unregulated Emissions

Selected analyses were performed for N-nitrosamines, organic sulfides, organic amines, and phenols. There was no apparent relationship of fuel properties to emission levels for these compounds. The high nitrogen content in the EDS Naphtha blend (115 ppm nitrogen) had no measureable effect on the nitrosamine emissions, with both the base fuel and the EDS Naphtha blend giving no detectable levels of nitrosamines. Inconsistant organic sulfide results were obtained from the two high-sulfur-content fuels, one giving higher organic sulfide emissions than the base fuel and the other giving lower levels (base fuel, 0.11 mg/km; EDS Naphtha blend, 0.00 mg/km; H-Coal Naphtha blend, 0.66 mg/km). The EDS Naphtha blend gave lower total phenol emissions than the base fuel (3.07 mg/km versus 11.58 mg/km). Trimethylamine (0.01 mg/km) was the only organic amine detected in a FTP exhaust sample for the base fuel.

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16. Warner, M.A., "Filter Extraction Procedures and Results for Various EPA/ECTD Particulate Samples," Final Report to Environmental Protection Agency under Task Specification 9 of Contract No. 68-03-2884, August 1982.

APPENDICES

A - General Information
B - Individual and Average Test Results Summary Tables
C - FTP Individual Sample Results
D - Computer Printouts of the Regulated Emissions Test Results

APPENDIX A

GENERAL INFORMATION

A-1 - Properties of Stock Fuels

A-2 - Lead Removal Process for Sasol Gasoline

A-3 - Calculations for Unregulated Emissions

APPENDIX A-1. PROPERTIES OF STOCK FUELS

Fuel Code Description	EM-338-F base petroleum gasoline	EM-481-F "EDS Naphtha from coal tar	EM-540-F "Leaded" Sasol Gasoline Coal Derived	EM-513-F H-Coal Naphtha
Gravity, °API	60.6	43.1	62.3	43.4
Density, g/mℓ	0.737	0.810	0.7301	
Octane, research (RON)	97.7	71.2	92.7	80.0
Octane, motor (MON)	89.5	65.2	81.0	73.5
RVP, psi	8.9	~0.5	7.8	4.4
Carbon, %	85.66±0.28	85.20±0.21		
Hydrogen, %	13.81±0.07	13.12±0.06		
Nitrogen, ppm		~500		
Sulfur, %	0.009	0.45		0.27
Lead, g/gal	<0.002		1.97	
Aromatics, %	22.8	25.9		31.1
Saturates, %	75.2	72.6		67.8
Olefins, %	2.0	1.5		1.1
Oxid. stability, min	600.			
Gum, unwashed, mg/100 mℓ	2.2			
Gum, washed, mg/100 mℓ	0.7			
Distillation - D86 °C (°F)				
IBP	33(92)	86(186)		49(121)
5%	39(103)	109(228)		75(167)
10%	49(121)	114(238)		88(191)
15%		119(246)		97(207)
20%	69(156)	124(256)		104(220)
30%	87(188)	133(271)		116(240)
40%	97(206)	140(284)		127(261)
50%	103(217)	148(298)		139(283)
60%	108(226)	156(312)		152(305)
70%	114(237)	162(324)		163(325)
80%	125(257)	169(336)		173(344)
90%	154(309)	176(348)		186(366)
95%	168(334)	181(358)		198(398)
EP	208(406)	201(394)		215(419)
Recovery, %	95.0			98
Residue, %		0.5		0.8

APPENDIX A-2. LEAD REMOVAL PROCESS FOR SASOL GASOLINE

As received at SwRI, the Sasol gasoline contained 1.97 g/gal lead. Because of this lead content, the fuel was not compatible with the catalyst-equipped test vehicle. In order to test the fuel in the vehicle, the Project Officer requested that an attempt be made to remove the lead from the fuel. Based on discussions with the Project Officer and with Dr. Jim Hincap of Ethyl Corporation, it was determined that a method involving stannic chloride would be the most practical to remove the lead from the fuel. This method involves stirring 5 gallons of leaded fuel with 100 ml of anhydrous stannic chloride for 10 minutes, followed by a water wash to remove the lead and tin salts. The fuel, upon separation from the water and filtration to remove any solid material, is ready to be used as an unleaded fuel.

In order to determine the applicability of the stannic chloride method to the Sasol gasoline, one gallon of Sasol gasoline was reacted with 20 ml of stannic chloride. The resulting unleaded fuel was analyzed and found to contain less than 0.02 g/gal of lead. The process was scaled up to produce five gallons of de-leaded Sasol gasoline. The research octane number (RON) of the Sasol gasoline, however, was also lowered from 92.7 to 81 with the removal of the lead. To prepare a suitable test fuel, the de-leaded Sasol gasoline was blended with the base fuel and n-butane. The fuel blend consisted of 48.3% de-leaded Sasol gasoline, 48.3% base fuel, and 3.4% n-butane. The fuel properties of this blend can be found in Table 2 of the text.

APPENDIX A-3. CALCULATIONS FOR UNREGULATED EMISSIONS

This appendix documents the calculational methods used for the unregulated emissions. All values not defined (i.e., CVS FLOW, VOL, etc.) are obtained from the computer printouts for the regulated emissions. Example printout is included as Table 1.

A. Individual Hydrocarbons

1. For FTP Evaluations only, convert 2-Bag UDDS to Equivalent 1-Bag UDDS:

$$\text{PPM 12} = \frac{\text{PPM}_1 \times \text{CVS FLOW}_1 + \text{PPM}_2 \times \text{CVS FLOW}_2}{\text{CVS FLOW}_1 + \text{CVS FLOW}_2}$$

$$\text{PPM 34} = \frac{\text{PPM}_3 \times \text{CVS FLOW}_3 + \text{PPM}_4 \times \text{CVS FLOW}_4}{\text{CVS FLOW}_3 + \text{PPM FLOW}_4}$$

2. Convert PPM to $\mu g/m^3$:

$$\mu g/m^3 = 35.32 \times \text{DENSITY} \times \text{PPM}$$

	Density, g/ft^3		
Methane CH_4	- 18.86	Propane C_3H_8	- 17.29
Ethylene C_2H_4	- 16.50	Propylene C_3H_6	- 16.50
Ethane C_2H_6	- 17.68	Benzene C_6H_6	- 15.33
Acetylene C_2H_2	- 15.33	Toluene C_7H_8	- 15.49

B. Calculation of mg/km

$$\text{mg/km} = [(\text{EXH} \times \text{SCF} - \text{BG} \times \text{DFC}) \times \text{VOL} \div \text{KM}] \div 1000$$

Calculations were performed using a Hewlett-Packard HP-65 Programmable Calculator. Dry (DVC) and (SFC) were used for all unregulated emissions except IHC. DFC and SFC are obtained from the computer printout for regulated emissions. (See Tables 1 and 2).

C. Calculation for 4-FTP (Aldehydes, Phenols, Organic Sulfides, Individual Hydrocarbons, Particulates, and Sulfate)

Composite 4-FTP = 0.43 × (Value for 1 & 2) + 0.57 × (Value for 3 & 4). Only one sample was taken over the entire 4-Bag FTP for nitrosamines, ammonia, total cyanide, and organic amines; therefore, calculations were performed as in B.

APPENDIX A-3 (Cont'd). CALCULATIONS FOR UNREGULATED EMISSIONS

TABLE 1. COMPUTER PRINTOUT NOMENCLATURE FOR FOUR-BAG FTP

FTP - VEHICLE EMISSIONS RESULTS -
PROJECT

TEST NO. RUN
VEHICLE MODEL
ENGINE
TRANSMISSION

VEHICLE NO.
DATE
BAG CART NO. / CVS NO.
DYNO NO.

TEST WEIGHT KG(LBS)
ACTUAL ROAD LOAD KW(HP)
GASOLINE
ODOMETER KM(MILES)

BAROMETER MM HG(IN HG)
RELATIVE HUMIDITY PCT
DRY BULB TEMP. DEG C(DEG F)
ABS. HUMIDITY GM/KG
NOX HUMIDITY CORRECTION FACTOR

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)				
BLOWER INLET P MM. H2O(IN. H2O)				
BLOWER INLET TEMP. DEG. C(DEG. F)				
BLOWER REVOLUTIONS				
TOT FLOW STD. CU. METRES(SCF)				
THC SAMPLE METER/RANGE/PPM				
THC BCKGRD METER/RANGE/PPM				
CO SAMPLE METER/RANGE/PPM				
CO BCKGRD METER/RANGE/PPM				
CO2 SAMPLE METER/RANGE/PCT				
CO2 BCKGRD METER/RANGE/PCT				
NOX SAMPLE METER/RANGE/PPM				
NOX BCKGRD METER/RANGE/PPM				
DILUTION FACTOR				
THC CONCENTRATION PPM				
CO CONCENTRATION PPM				
CO2 CONCENTRATION PCT				
NOX CONCENTRATION PPM				
THC MASS GRAMS				
CO MASS GRAMS				
CO2 MASS GRAMS				
NOX MASS GRAMS				
THC GRAMS/KM				
CO GRAMS/KM				
CO2 GRAMS/KM				
NOX GRAMS/KM				
FUEL CONSUMPTION BY CB L/100KM				
RUN TIME SECONDS				
MEASURED DISTANCE KM				
SCF, DRY				
DFC, WET (DRY)				
TOT VOL (SCM) / SAM BLR (SCM)				
KM (MEASURED)				
FUEL CONSUMPTION L/100KM				

COMPOSITE RESULTS

		3-BAG	(4-BAG)
TEST NUMBER			
BAROMETER	MM HG		
HUMIDITY	G/KG		
TEMPERATURE	DEG C		
CARBON DIOXIDE	G/KM		( )
FUEL CONSUMPTION	L/100KM		( )
HYDROCARBONS (THC)	G/KM		( )
CARBON MONOXIDE	G/KM		( )
OXIDES OF NITROGEN	G/KM		( )

APPENDIX A-3 (CONT'D). CALCULATIONS FOR UNREGULATED EMISSIONS
TABLE 2. DEFINITION OF COMPUTER PRINTOUT NOMENCLATURE

FOR FOUR-BAG AND SINGLE-BAG

REGULATED EMISSIONS

The following are primarily exerpts taken from the computer program:

```
C   DFC = DILUTION FACTOR CORRECTION  DFC = FOR WET SAMPLES  DFCD = FOR DRY

    DF(J)=13.4/(  YC2(2,J) +(( YH(2,J) + CC(2,J))/10000.))
    DFC(J) = 1 - 1/DF(J)

C   CALCULATE DFC, VOL. KM FOR BAGS 1+2 AND 3+4
C   DF = TOTAL CVS FLOW / EXHAUST FLOW = AIR + EXH / EXH
C   DFC = 1 - 1/DF = 1 - EXH/(AIR+EXH) = AIR/(AIR+EXH)
    DFC12 =(DFC(1)*VMIX(1) + DFC(2)*VMIX(2)) / (VMIX(1) + VMIX(2))
    DFC34 = (DFC(3)*VMIX(3) + DFC(4)*VMIX(4)) / (VMIX(3) + VMIX(4))
    IF(RH.LT.20) RH = 20
    DFCD12 = DFC12 * (1.0 - 0.000323*(RH - 20))
    DFCD34 = DFC34 * (1.0 - 0.000323*(RH - 20))

C   SCF = SAMPLE CORRECTION FACTOR FOR WATER REMOVAL   SCF = FOR WET  SCFD=DRY
    SCF12 = 1.000
    SCF34 = 1.000
    SCFD12 = (SCFD(1)*VMIX(1)+SCFD(2)+VMIX(2)) / (VMIX(1) + VMIX(2))
    SCFD34 = (SCFD(3)*VMIX(3)+SCFD(4)*VMIX(4)) / (VMIX(3) + VMIX(4))


C   CALCULATE 4-BAG EMISSIONS AND FUEL CONSUMPTION
C   4-BAG = 0.43*(BAG1+BAG2)/(MILES1+MILES2)+0.57*(BAG3+BAG4)/(MILES3+MILES4)
    DISTA=MILES(1) + MILES(2)
    DISTB=MILES(2) + MILES(3)
    DISTC=MILES(3) + MILES(4)

    HCWM4 = 0.43*((HCM(1)+HCM(2)) / DISTA) + 0.57*((HCM(3)+HCM(4)) / DISTC)
    COWM4 = 0.43*((COM(1)+COM(2)) / DISTA) + 0.57*((COM(3)+COM(4)) / DISTC)
    CO2WM4= 0.43*((CO2M(1)+CO2M(2))/DISTA) + 0.57*((CO2M(3)+CO2M(4)) / DISTC)
    NOXWM4= 0.43*((NOXM(1)+NOXM(2))/DISTA) + 0.57*((NOXM(3)+NOXM(4)) / DISTC)
    CBFE4 = 2421. / (.866*HCWM4 + .429*COWM4 + .273*CO2WM4)
```

APPENDIX B

INDIVIDUAL AND AVERAGE TEST RESULTS SUMMARY TABLES

Table B-	Test No.	Fuel	Fuel Code
1	851-3	Base	EM-338-F
2	854-5	Mobil "MTG"	EM-486-F
3	856-7	Simulated Coal	EM-468-F
4	858-9	EDS Naphtha Blend	EM-488-F
5	861-2	Sasol Blend	EM-542-F
6	863-4	H-Coal Naphtha Blend	EM-543-F

TABLE B-1. SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-338-F BASE PETROLEUM GASOLINE

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
	851	852	853	Average	851	852	853	Average
Barometer, mm Hg	751.6	739.6	743.5	744.9	751.6	739.1	743.7	744.8
Humidity, g/kg	5.7	12.0	9.0	8.9	5.8	11.8	9.5	9.0
Carbon Dioxide, g/km	226.7	236.9	228.6	230.7	177.5	184.2	177.3	179.7
Fuel Consumption, ℓ/100 km	9.73	10.17	9.81	9.90	7.64	7.93	7.63	7.73
Regulated Emissions								
Hydrocarbons, (THC), g/km	0.07	0.07	0.06	0.07	0.07	0.07	0.06	0.07
Carbon Monoxide, g/km	0.59	0.72	0.71	0.67	0.78	0.80	0.75	0.78
Oxides of Nitrogen, g/km	0.11	0.09	0.11	0.10	0.04	0.05	0.03	0.04
Particulates								
Total Particulates	9.73	7.39	4.78	7.30	23.56	25.03	11.29	19.96
Sulfate		0.51	0.30	0.41		1.98	1.18	1.58
Compound Group Totals								
Aldehydes & Ketones	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual Hydrocarbons	25.8	28.5	21.2	25.2	38.0	39.2	33.1	36.8
Organic Sulfides		0.08	0.13	0.11				
Organic Amines								
Phenols		0.00	0.01	0.01				
Nitrosamines		11.58						
				0.000		5.96		
Other Compounds								
Ammonia								
Total Cyanide		12.03	21.97	17.00				
		0.00	0.03	0.02				
Aldehydes & Ketones								
Formaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acetaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Acetone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Methylethylketone	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hexanaldehyde	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE B-1 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-338-F BASE PETROLEUM GASOLINE

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
	851	852	853	Average	851	852	853	Average
Individual Hydrocarbons								
Methane	8.36	9.34	8.40	8.70	17.25	17.81	16.14	17.07
Ethylene	2.72	3.40	2.87	3.00	2.57	2.84	2.33	2.58
Ethane	1.55	1.62	1.61	1.59	4.08	4.06	3.53	3.89
Acetylene	0.97	1.20	1.08	1.08	0.00	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Propylene	2.43	2.80	--	2.62	3.36	3.05	--	3.21
Benzene	3.88	4.15	1.88	3.30	6.28	6.51	6.59	6.46
Toluene	5.86	5.98	5.36	5.73	4.45	4.91	4.47	4.61
Organic Sulfides								
Carbonyl Sulfide		0.02	0.00	0.01				
Methyl Sulfide		0.04	0.08	0.06				
Ethyl Sulfide		0.02	0.04	0.03				
Methyl Disulfide		0.00	0.01	0.01				
Organic Amines								
Monomethylamine		0.00	0.00	0.00				
Monoethylamine		0.00	0.00	0.00				
Trimethylamine		0.00	0.01	0.01				
Diethylamine		0.00	0.00	0.00				
Triethylamine		0.00	0.00	0.00				
Phenols								
Phenol		0.00				0.00		
Salicyaldehyde		0.00				0.00		
m- and p-cresol		0.03				0.00		
Five*		0.00				0.00		
2-n-propylphenol		0.00				0.00		
2,3,5-trimethylphenol		0.04				0.00		
2,3,5,6-tetramethylphenol		11.15				5.96		

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,4-xylenol; 2,4,5-trimethylphenol

TABLE B-1 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-338-F BASE PETROLEUM GASOLINE

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
Trace Elements	851	852	853	Average	851	852	853	Average
Sodium			0.00				0.00	
Sulfur			0.03				0.07	
Vanadium			0.02				0.00	
Mercury			0.00				0.00	
Magnesium			0.00				0.00	
Chlorine			0.02				0.41	
Chromium			0.00				0.00	
Copper			0.00				0.00	
Lead			0.00				0.00	
Aluminum			0.10				0.00	
Manganese			0.00				0.03	
Zinc			0.03				0.00	
Tungsten			0.00				0.00	
Silicon			0.01				0.00	
Calcium			0.08				0.03	
Iron			0.91				0.27	
Barium			0.05				0.02	
Arsenic			0.00				0.00	
Phosphorus			0.02				0.00	
Bromine			0.00				0.00	
Strontium			0.33				0.26	
Molybdenum			0.56				0.48	

Note: Nickel, Cadmium, Tin, Potassium, Antimony, Selenium, Titanium, Cobalt, and Platinum were also analyzed for, but were detected at or below 0.02 mg/km for all filters analyzed in this program

TABLE B-2. SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-486-F MOBIL "MTG" GASOLINE

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted) FTP 854	FTP 855	FTP ____	FTP Average	HFET 854	HFET ____	HFET ____	HFET Average
Barometer, mm Hg	741.7	738.9		740.3	741.2			
Humidity, g/kg	6.3	12.0		9.2	6.7			
Carbon Dioxide, g/km	226.4	226.6		226.5	177.5			
Fuel Consumption, ℓ/100 km	9.73	9.75		9.74	7.63			
Regulated Emissions								
Hydrocarbons, (THC), g/km	0.06	0.05		0.06	0.03			
Carbon Monoxide, g/km	0.63	0.74		0.69	0.43			
Oxides of Nitrogen, g/km	0.18	0.12		0.15	0.05			
Particulates								
Total Particulates	3.21	3.32		3.27	2.83			
Sulfate	0.44			0.44	0.55			
Compound Group Totals								
Aldehydes & Ketones	0.2	0.0		0.1	0.8			
Individual Hydrocarbons	16.6	17.1		16.9	13.1			
Organic Sulfides								
Organic Amines								
Phenols								
Nitrosamines								
Other Compounds								
Ammonia	11.18			11.18				
Total Cyanide								
Aldehydes & Ketones								
Formaldehyde	0.00	0.00		0.00	0.00			
Acetaldehyde	0.00	0.00		0.00	0.00			
Acetone	0.00	0.00		0.00	0.00			
Methylethylketone	0.17	0.00		0.09	0.83			
Hexanaldehyde	0.00	0.00		0.00	0.00			

TABLE B-2 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-486-F MOBIL "MTG" GASOLINE

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
	854	855	_____	Average	854	_____	_____	Average
Individual Hydrocarbons								
Methane	7.44	8.42		7.93	6.93			
Ethylene	2.78	3.26		3.02	0.92			
Ethane	0.76	0.99		0.88	1.38			
Acetylene	1.20	1.23		1.22	0.00			
Propane	0.27	0.00		0.14	0.00			
Propylene	1.67	1.84		1.76	0.00			
Benzene	1.32	1.35		1.34	3.89			
Toluene	1.13	0.00		0.57	0.00			
Organic Sulfides								
Carbonyl Sulfide								
Methyl Sulfide								
Ethyl Sulfide								
Methyl Disulfide								
Organic Amines								
Monomethylamine								
Monoethylamine								
Trimethylamine								
Diethylamine								
Triethylamine								
Phenols								
Phenol								
Salicyaldehyde								
m- and p-cresol								
Five*								
2-n-propylphenol								
2,3,5-trimethylphenol								
2,3,5,6-tetramethylphenol								

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,4-xylenol; 2,4,5-trimethylphenol

TABLE B-2 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-486-F MOBIL "MTG" GASOLINE

Test Number,	VFD	EMISSION RATE, mg/km (Except as Noted)					
		FTP			HFET		
Trace Elements		854	858	Average	854	855	Average
Sodium							
Sulfur		0.00			0.00		
Vanadium		0.01			0.01		
Mercury		0.00			0.00		
Magnesium		0.00			0.00		
Chlorine		0.00			0.00		
		0.00			0.01		
Chromium							
Copper		0.00			0.00		
Lead		0.00			0.00		
Aluminum		0.00			0.00		
Manganese		0.01			0.00		
Zinc		0.00			0.01		
		0.02			0.00		
Tungsten					0.00		
Silicon		0.00					
Calcium		0.00			0.00		
Iron		0.05			0.00		
Barium		0.07			0.04		
		0.03			0.03		
Arsenic					0.02		
Phosphorus		0.00					
Bromine		0.01			0.00		
Strontium		0.00			0.01		
Molybdenum		0.24			0.00		
		0.39			0.00		
					0.00		

Note: Nickel, Cadmium, Tin, Potassium, Antimony, Selenium, Titanium, Cobalt, and Platinum were also analyzed for, but were detected at or below 0.02 mg/km for all filters analyzed in this program

TABLE B-3. SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-468-F SIMULATED COAL GASOLINE

Test Number,	VFD	EMISSION RATE, mg/km (Except as Noted) FTP 856	FTP 857	FTP Average	HFET 856	HFET Average
Barometer,	mm Hg	747.5	747.0	747.3	748.5	
Humidity,	g/kg	4.5	3.2	3.9	3.5	
Carbon Dioxide,	g/km	223.4	225.9	224.7	185.8	
Fuel Consumption,	ℓ/100 km	9.18	9.29	9.24	7.66	
Regulated Emissions						
Hydrocarbons, (THC),	g/km	0.06	0.08	0.07	0.04	
Carbon Monoxide,	g/km	0.34	0.35	0.35	0.62	
Oxides of Nitrogen,	g/km	0.13	0.14	0.14	0.08	
Particulates						
Total Particulates		2.80	5.04	3.92	4.49	
Sulfate						
Compound Group Totals						
Aldehydes & Ketones		0.0	0.0	0.0	0.0	
Individual Hydrocarbons		20.8	26.1	23.5	17.7	
Organic Sulfides						
Organic Amines						
Phenols						
Nitrosamines						
Other Compounds						
Ammonia						
Total Cyanide						
Aldehydes & Ketones						
Formaldehyde		0.00	0.00	0.00	0.00	
Acetaldehyde		0.00	0.00	0.00	0.00	
Acetone		0.00	0.00	0.00	0.00	
Methylethylketone		0.00	0.00	0.00	0.00	
Hexanaldehyde		0.00	0.00	0.00	0.00	

TABLE B-3 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-468-F SIMULATED COAL GASOLINE

	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
Test Number, VFD	856	857		Average	856			Average
Individual Hydrocarbons								
Methane	6.02	6.64		6.33	8.21			
Ethylene	3.36	4.49		3.93	2.01			
Ethane	1.41	0.85		1.13	2.16			
Acetylene	1.21	1.53		1.37	0.00			
Propane	0.00	0.00		0.00	0.00			
Propylene	1.74	2.08		1.91	0.00			
Benzene	2.62	3.83		3.23	5.36			
Toluene	4.48	6.67		5.58	0.00			
Organic Sulfides								
Carbonyl Sulfide								
Methyl Sulfide								
Ethyl Sulfide								
Methyl Disulfide								
Organic Amines								
Monomethylamine								
Monoethylamine								
Trimethylamine								
Diethylamine								
Triethylamine								
Phenols								
Phenol								
Salicyaldehyde								
m- and p-cresol								
Five*								
2-n-propylphenol								
2,3,5-trimethylphenol								
2,3,5,6-tetramethylphenol								

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,4-xylenol; 2,4,5-trimethylphenol

TABLE B-3 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-468-F SIMULATED COAL GASOLINE

Test Number,	VFD	EMISSION RATE, mg/km (Except as Noted)							
		FTP				HFET			
		856	857		Average	856	857		Average
Trace Elements									
Sodium		0.00				0.00			
Sulfur		0.01				0.01			
Vanadium		0.00				0.00			
Mercury		0.00				0.00			
Magnesium		0.00				0.00			
Chlorine		0.28				0.51			
Chromium		0.00				0.00			
Copper		0.00				0.00			
Lead		0.00				0.00			
Aluminum		0.01				0.01			
Manganese		0.00				0.00			
Zinc		0.02				0.04			
Tungsten		0.00				0.00			
Silicon		0.00				0.00			
Calcium		0.07				0.05			
Iron		0.09				0.04			
Barium		0.04				0.03			
Arsenic		0.00				0.00			
Phosphorus		0.01				0.01			
Bromine		0.00				0.00			
Strontium		0.15				0.00			
Molybdenum		0.29				0.00			

Note: Nickel, Cadmium, Tin, Potassium, Antimony, Selenium, Titanium, Cobalt, and Platinum were also analyzed for, but were detected at or below 0.02 mg/km for all filters analyzed in this program

TABLE B-4. SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-488-F EDS NAPHTHA BLEND

		EMISSION RATE, mg/km (Except as Noted)							
		FTP				HFET			
Test Number,	VFD	858	859	———	Average	858	———	———	Average
Barometer,	mm Hg	736.6	748.0		742.3	737.1			
Humidity,	g/kg	5.4	6.0		5.7	5.7			
Carbon Dioxide,	g/km	216.0	225.6		220.8	168.9			
Fuel Consumption,	ℓ/100 km	9.23	9.64		9.44	7.28			
Regulated Emissions									
Hydrocarbons, (THC),	g/km	0.09	0.08		0.09	0.08			
Carbon Monoxide,	g/km	0.80	0.78		0.79	1.56			
Oxides of Nitrogen,	g/km	0.18	0.18		0.18	0.10			
Particulates									
Total Particulates		3.64	2.99		3.32	3.19			
Sulfate		0.65				0.52			
Compound Group Totals									
Aldehydes & Ketones		0.0	0.0		0.0	0.0			
Individual Hydrocarbons		26.1	32.7		29.4	38.9			
Organic Sulfides			0.00						
Organic Amines		--							
Phenols		3.07				0.06			
Nitrosamines					0.000				
Other Compounds									
Ammonia		1.15							
Total Cyanide		0.27							
Aldehydes & Ketones									
Formaldehyde		0.00	0.00		0.00	0.00			
Acetaldehyde		0.00	0.00		0.00	0.00			
Acetone		0.00	0.00		0.00	0.00			
Methylethylketone		0.00	0.00		0.00	0.00			
Hexanaldehyde		0.00	0.00		0.00	0.00			

TABLE B-4 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-488-F EDS NAPHTHA BLEND

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
	858	859		Average	858			Average
Individual Hydrocarbons								
Methane	7.10	16.60		11.85	18.96			
Ethylene	4.46	3.49		3.98	3.95			
Ethane	3.58	2.78		3.18	4.98			
Acetylene	1.30	1.08		1.19	0.00			
Propane	0.00	0.00		0.00	0.00			
Propylene	2.68	2.50		2.59	2.39			
Benzene	2.30	2.15		2.23	4.70			
Toluene	4.71	4.09		4.40	3.94			
Organic Sulfides								
Carbonyl Sulfide		0.00						
Methyl Sulfide		0.00						
Ethyl Sulfide		0.00						
Methyl Disulfide		0.00						
Organic Amines								
Monomethylamine	--							
Monoethylamine	--							
Trimethylamine	--							
Diethylamine	--							
Triethylamine	--							
Phenols								
Phenol	0.00				0.00			
Salicyaldehyde	0.00				0.00			
m- and p-cresol	0.00				0.00			
Five*	0.00				0.00			
2-n-propylphenol	0.00				0.00			
2,3,5-trimethylphenol	0.00				0.00			
2,3,5,6-tetramethylphenol	3.07				0.06			

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,4-xylenol; 2,4,5-trimethylphenol

TABLE B-4 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT,
EM-488-F EDS NAPHTHA BLEND

Test Number,	VFD	EMISSION RATE, mg/km (Except as Noted)							
		FTP				HFET			
		858	859		Average	858	859		Average
Trace Elements									
Sodium		0.00				0.00			
Sulfur		0.04				0.03			
Vanadium		0.00				0.00			
Mercury		0.00				0.00			
Magnesium		0.00				0.00			
Chlorine		0.05				0.19			
Chromium		0.00				0.00			
Copper		0.00				0.00			
Lead		0.00				0.00			
Aluminum		0.02				0.01			
Manganese		0.00				0.00			
Zinc		0.03				0.03			
Tungsten		0.00				0.00			
Silicon		0.00				0.00			
Calcium		0.11				0.07			
Iron		0.17				0.15			
Barium		0.07				0.04			
Arsenic		0.00				0.00			
Phosphorus		0.04				0.02			
Bromine		0.00				0.00			
Strontium		0.00				0.00			
Molybdenum		0.00				0.00			

Note: Nickel, Cadmium, Tin, Potassium, Antimony, Selenium, Titanium, Cobalt, and Platinum were also analyzed for, but were detected at or below 0.02 mg/km for all filters analyzed in this program

TABLE B-5. SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-542-F SASOL BLEND

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
	861	862		Average	861			Average
Barometer, mm Hg	740.7	740.4		740.6	740.2			
Humidity, g/kg	5.0	5.8		5.4	5.0			
Carbon Dioxide, g/km	207.7	210.2		209.0	159.5			
Fuel Consumption, ℓ/100 km	9.14	9.26		9.20	7.00			
Regulated Emissions								
Hydrocarbons, (THC), g/km	0.14	0.16		0.15	0.07			
Carbon Monoxide, g/km	0.90	0.95		0.93	0.42			
Oxides of Nitrogen, g/km	0.51	0.55		0.53	0.18			
Particulates								
Total Particulates	35.88	34.64		35.26	94.22			
Sulfate	0.52				0.40			
Compound Group Totals								
Aldehydes & Ketones	0.2	0.0		0.1	0.0			
Individual Hydrocarbons	56.5	53.0		54.8	30.2			
Organic Sulfides								
Organic Amines								
Phenols								
Nitrosamines								
Other Compounds								
Ammonia	10.43							
Total Cyanide	0.32							
Aldehydes & Ketones								
Formaldehyde	0.00	0.00		0.00	0.00			
Acetaldehyde	0.20	0.00		0.10	0.00			
Acetone	0.00	0.00		0.00	0.00			
Methylethylketone	0.00	0.00		0.00	0.00			
Hexanaldehyde	0.00	0.00		0.00	0.00			

TABLE B-5 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-542-F SASOL BLEND

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
	861	862		Average	861			Average
Individual Hydrocarbons								
Methane	24.78	21.57		23.18	14.73			
Ethylene	7.76	7.10		7.43	3.55			
Ethane	6.83	6.91		6.87	3.00			
Acetylene	0.93	0.91		0.92	0.00			
Propane	0.22	0.00		0.11	0.00			
Propylene	5.86	4.61		5.24	3.63			
Benzene	3.88	4.06		3.97	3.15			
Toluene	6.27	7.84		7.06	2.14			
Organic Sulfides								
Carbonyl Sulfide								
Methyl Sulfide								
Ethyl Sulfide								
Methyl Disulfide								
Organic Amines								
Monomethylamine								
Monoethylamine								
Trimethylamine								
Diethylamine								
Triethylamine								
Phenols								
Phenol								
Salicyaldehyde								
m- and p-cresol								
Five*								
2-n-propylphenol								
2,3,5-trimethylphenol								
2,3,5,6-tetramethylphenol								

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,4-xylenol; 2,4,5-trimethylphenol

TABLE B-5 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-542-F SASOL BLEND

Test Number,	VFD	EMISSION RATE, mg/km (Except as Noted) FTP 861	FTP 862	FTP ____	FTP Average	HFET 861	HFET 862	HFET ____	HFET Average
Trace Elements									
Sodium		0.01				0.11			
Sulfur		0.15				0.16			
Vanadium		0.00				0.00			
Mercury		0.00				0.01			
Magnesium		0.01				0.03			
Chlorine		22.23				64.81			
Chromium		0.00				0.00			
Copper		0.01				0.01			
Lead		0.00				0.02			
Aluminum		0.21				0.19			
Manganese		0.03				0.02			
Zinc		0.03				0.04			
Tungsten		0.00				0.04			
Silicon		0.02				0.02			
Calcium		0.13				0.11			
Iron		3.28				2.56			
Barium		0.07				0.07			
Arsenic		0.04				0.05			
Phosphorus		0.05				0.04			
Bromine		0.96				10.94			
Strontium		0.04				0.14			
Molybdenum		0.06				0.16			

Note: Nickel, Cadmium, Tin, Potassium, Antimony, Selenium, Titanium, Cobalt, and Platinum were also analyzed for, but were detected at or below 0.02 mg/km for all filters analyzed in this program

TABLE B-6. SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-543-F H-COAL NAPHTHA BLEND

Test Number,	VFD	EMISSION RATE, mg/km (Except as Noted) FTP 863	FTP 864	FTP ____	FTP Average	HFET 863	HFET ____	HFET ____	HFET Average
Barometer,	mm Hg	740.4	732.0		736.2	740.4			
Humidity,	g/kg	9.1	9.9		9.5	8.2			
Carbon Dioxide,	g/km	220.3	220.2		220.3	163.7			
Fuel Consumption,	ℓ/100 km	9.32	9.35		9.34	6.92			
Regulated Emissions									
Hydrocarbons, (THC),	g/km	0.14	0.12		0.13	0.06			
Carbon Monoxide,	g/km	1.17	1.76		1.47	0.84			
Oxides of Nitrogen,	g/km	0.38	0.55		0.47	0.25			
Particulates									
Total Particulates		14.91	33.54		24.23	26.09			
Sulfate		0.70				1.78			
Compound Group Totals									
Aldehydes & Ketones		0.0	0.0		0.0	0.0			
Individual Hydrocarbons		47.0	44.6		45.8	25.6			
Organic Sulfides		0.66							
Organic Amines		--							
Phenols									
Nitrosamines									
Other Compounds									
Ammonia		14.24							
Total Cyanide		0.06							
Aldehydes & Ketones									
Formaldehyde		0.00	0.00		0.00	0.00			
Acetaldehyde		0.00	0.00		0.00	0.00			
Acetone		0.00	0.00		0.00	0.00			
Methylethylketone		0.00	0.00		0.00	0.00			
Hexanaldehyde		0.00	0.00		0.00	0.00			

TABLE B-6 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-543-F H-COAL NAPHTHA BLEND

Test Number, VFD	EMISSION RATE, mg/km (Except as Noted)							
	FTP				HFET			
	863	864		Average	863			Average
Individual Hydrocarbons								
Methane	21.76	22.08		21.92	15.22			
Ethylene	6.30	5.78		6.04	2.81			
Ethane	3.94	4.64		4.29	3.10			
Acetylene	1.11	0.93		1.02	0.00			
Propane	0.31	0.00		0.16	0.00			
Propylene	3.06	3.19		3.13	0.00			
Benzene	3.47	3.41		3.44	3.02			
Toluene	7.00	4.54		5.77	1.43			
Organic Sulfides								
Carbonyl Sulfide	0.64							
Methyl Sulfide	0.00							
Ethyl Sulfide	0.01							
Methyl Disulfide	0.01							
Organic Amines								
Monomethylamine	--							
Monoethylamine	--							
Trimethylamine	--							
Diethylamine	--							
Triethylamine	--							
Phenols								
Phenol								
Salicyaldehyde								
m- and p-cresol								
Five*								
2-n-propylphenol								
2,3,5-trimethylphenol								
2,3,5,6-tetramethylphenol								

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,4-xylenol; 2,4,5-trimethylphenol

TABLE B-6 (Cont'd). SUMMARY OF EMISSIONS FROM 1981 VW RABBIT, EM-543-F H-COAL NAPHTHA BLEND

Test Number,	VFD	EMISSION RATE, mg/km (Except as Noted)					
		FTP			HFET		
Trace Elements		863	864	Average	863	864	Average
Sodium							
Sulfur		0.02					
Vanadium		0.26					
Mercury		0.00			0.05		
Magnesium		0.02			0.36		
Chlorine		0.01			0.00		
		2.05			0.06		
Chromium					0.01		
Copper		0.02			8.49		
Lead		0.03					
Aluminum		0.65			0.04		
Manganese		0.14			0.02		
Zinc		0.01			0.46		
		0.08			0.07		
Tungsten					0.01		
Silicon		0.00			0.05		
Calcium		0.04					
Iron		0.16			0.00		
Barium		2.19			0.01		
		0.10			0.10		
Arsenic					1.09		
Phosphorus		0.01			0.06		
Bromine		0.07					
Strontium		0.33			0.00		
Molybdenum		0.11			0.04		
		0.18			2.27		
					0.05		
					0.00		

Note: Nickel, Cadmium, Tin, Potassium, Antimony, Selenium, Titanium, Cobalt, and Platinum were also analyzed for, but were detected at or below 0.02 mg/km for all filters analyzed in this program

Appendix C

FTP Individual Sample Results

Table C-	Test No.	Fuel	Fuel Code
1-3	851-3	Base	EM-338-F
4-5	854-5	Mobil "MTG"	EM-486-F
6-7	856-7	Simulated Coal	EM-468-F
8-9	858-9	EDS Naphtha Blend	EM-488-F
10-11	861-2	Sasol Blend	EM-542-F
12-13	863-4	H-Coal Naphtha Blend	EM-543-F

TABLE C-1. FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Base Fuel EM-338-F

Test 851

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	14.52	6.11
Sulfate		
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	1.90	0.19	0.80	0.16
Ethylene	1.69	0.00	0.07	0.00
Ethane	0.52	0.04	0.21	0.01
Acetylene	0.65	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.53	0.00	0.00	0.00
Benzene	0.90	0.79	0.28	0.00
Toluene	3.27	0.00	0.50	0.00

TABLE C-2. FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Base Fuel EM-338-F

Test 852

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	9.17	6.05
Sulfate	0.77	0.31
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	2.38	0.16	1.13	0.07
Ethylene	1.91	0.00	0.18	0.00
Ethane	0.60	0.00	0.26	0.00
Acetylene	0.81	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.76	0.00	0.00	0.00
Benzene	0.93	0.79	0.40	0.00
Toluene	3.14	0.00	0.68	0.00

TABLE C-2 (CONT'D.). FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Base Fuel EM-338-F

Test 852

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Organic Sulfides		
Carbonyl Sulfide	0.04	0.00
Methyl Sulfide	0.02	0.05
Ethyl Sulfide	0.00	0.03
Methyl Disulfide	0.00	0.00
Phenols		
Phenol	0.00	0.00
Salicyaldehyde	0.00	0.00
m- and p-cresol	0.00	0.06
Five*	0.00	0.00
2-n-propylphenol	0.00	0.00
2,3,5 trimethylphenol	0.00	0.71
2,3,5,6 tetramethylphenol	0.00	19.57

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,5-xylenol; 2,4,6 trimethylphenol

TABLE C-3 . FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Base Fuel EM-338-F

Test 853

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	5.95	3.89
Sulfate	0.13	0.44
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	2.14	0.22	0.74	0.05
Ethylene	1.82	0.00	0.01	0.00
Ethane	0.54	0.05	0.19	0.01
Acetylene	0.74	0.00	0.00	0.00
Propane	0.04	0.00	0.00	0.00
Propylene	1.01	0.00	0.00	0.00
Benzene	1.08	0.00	0.13	0.00
Toluene	3.59	0.00	0.00	0.00

TABLE C-3 (CONT'D.). FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Base Fuel EM-338-F

Test 853

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Organic Sulfides		
Carbonyl Sulfide	0.00	0.00
Methyl Sulfide	0.08	0.08
Ethyl Sulfide	0.03	0.04
Methyl Disulfide	0.00	0.01
Phenols		
Phenol		
Salicyaldehyde		
m- and p-cresol		
Five*		
2-n-propylphenol		
2,3,5 trimethylphenol		
2,3,5,6 tetramethylphenol		

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,5-xylenol; 2,4,6 trimethylphenol

TABLE C-4 . FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Mobil MTG Gasoline EM-486-F

Test 854

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	3.66	2.87
Sulfate	0.54	0.37
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.30
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	1.70	0.29	0.42	0.14
Ethylene	1.80	0.00	0.00	0.00
Ethane	0.38	0.03	0.12	0.00
Acetylene	0.81	0.00	0.00	0.00
Propane	0.15	0.00	0.00	0.00
Propylene	1.07	0.00	0.00	0.00
Benzene	0.91	0.00	0.00	0.00
Toluene	0.76	0.00	0.00	0.00

TABLE C-5 . FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Mobil MTG Gasoline EM-486-F

Test 855

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	5.07	2.00
Sulfate		
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	1.98	1.20	1.60	1.34
Ethylene	1.97	0.00	0.08	0.00
Ethane	0.40	0.00	0.14	0.00
Acetylene	0.85	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.17	0.00	0.00	0.00
Benzene	0.93	0.00	0.00	0.00
Toluene	0.00	0.00	0.00	0.00

TABLE C-6 . FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Simulated Coal Gasoline EM-468-F

Test 856

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	3.79	2.06
Sulfate		
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	1.75	0.07	0.35	0.00
Ethylene	2.14	0.00	0.00	0.04
Ethane	0.43	0.09	0.19	0.00
Acetylene	0.82	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.10	0.00	0.00	0.00
Benzene	1.78	0.00	0.00	0.00
Toluene	3.00	0.00	0.00	0.00

TABLE C-7 . FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Simulated Coal Gasoline EM-468-F

Test 857

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	3.92	5.89
Sulfate		
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	1.78	0.01	0.47	0.10
Ethylene	2.49	0.00	0.22	0.02
Ethane	0.39	0.02	0.16	0.00
Acetylene	1.02	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.30	0.00	0.00	0.00
Benzene	2.34	0.00	0.19	0.00
Toluene	4.46	0.00	0.00	0.00

TABLE C-8 . FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

EDS Naphtha Blend EM-488-F

Test 858

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	4.82	2.75
Sulfate	0.70	0.62
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	2.12	0.00	0.87	0.00
Ethylene	2.52	0.00	0.24	0.00
Ethane	0.82	0.20	0.45	0.17
Acetylene	0.90	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.72	0.00	0.00	0.00
Benzene	1.23	0.00	0.26	0.00
Toluene	2.86	0.00	0.26	0.00

TABLE C-8 (CONT'D.). FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

EDS Naphtha Blend EM-488-F

Test 858

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Organic Sulfides		
Carbonyl Sulfide		
Methyl Sulfide		
Ethyl Sulfide		
Methyl Disulfide		
Phenols		
Phenol	0.00	0.00
Salicyaldehyde	0.00	0.00
m- and p-cresol	0.00	0.00
Five*	0.00	0.00
2-n-propylphenol	0.00	0.00
2,3,5 trimethylphenol	0.00	0.00
2,3,5,6 tetramethylphenol	4.24	2.18

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,5-xylenol; 2,4,6 trimethylphenol

TABLE C-9 . FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

EDS Naphtha Blend EM-488-F

Test 859

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	3.84	2.35
Sulfate		
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	2.76	0.78	1.54	0.87
Ethylene	2.29	0.00	0.12	0.00
Ethane	0.68	0.09	0.33	0.14
Acetylene	0.74	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.57	0.00	0.00	0.00
Benzene	1.16	0.00	0.23	0.00
Toluene	2.74	0.00	0.00	0.00

TABLE C-9 (CONT'D.). FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

EDS Naphtha Blend EM-488-F

Test 859

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Organic Sulfides		
Carbonyl Sulfide	0.00	0.00
Methyl Sulfide	0.00	0.00
Ethyl Sulfide	0.00	0.00
Methyl Disulfide	0.00	0.00
Phenols		
Phenol		
Salicyaldehyde		
m- and p-cresol		
Five*		
2-n-propylphenol		
2,3,5 trimethylphenol		
2,3,5,6 tetramethylphenol		

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,5-xylenol; 2,4,6 trimethylphenol

TABLE C-10. FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Sasol Blend EM-542-F

Test 861

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	35.38	36.26
Sulfate	0.85	0.27
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.35
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	3.77	1.70	2.23	1.56
Ethylene	3.08	0.00	1.43	0.00
Ethane	1.04	0.49	0.72	0.55
Acetylene	0.64	0.00	0.00	0.00
Propane	0.13	0.00	0.00	0.00
Propylene	2.22	0.00	1.16	0.00
Benzene	1.68	0.00	0.77	0.00
Toluene	3.45	0.00	0.65	0.00

TABLE C-11. FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

Sasol Blend EM-542-F

Test 862

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	31.56	36.97
Sulfate		
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	3.21	1.34	1.99	1.40
Ethylene	2.54	0.00	1.50	0.00
Ethane	0.94	0.53	0.73	0.58
Acetylene	0.63	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.90	0.00	0.78	0.00
Benzene	1.64	0.00	0.86	0.00
Toluene	3.96	0.00	1.04	0.00

TABLE C-12. FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

H-Coal Naphtha Blend EM-543-F

Test 863

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	18.05	12.54
Sulfate	0.63	0.76
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	3.75	0.96	1.83	1.39
Ethylene	3.46	0.00	0.43	0.00
Ethane	0.88	0.19	0.44	0.24
Acetylene	0.77	0.00	0.00	0.00
Propane	0.19	0.00	0.00	0.00
Propylene	1.95	0.00	0.00	0.00
Benzene	1.85	0.00	0.41	0.00
Toluene	4.17	0.00	0.45	0.00

TABLE C-12 (CONT'D.). FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

H-Coal Naphtha Blend EM-543-F

Test 863

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Organic Sulfides		
Carbonyl Sulfide	1.14	0.26
Methyl Sulfide	0.00	0.00
Ethyl Sulfide	0.02	0.00
Methyl Disulfide	0.03	0.00
Phenols		
Phenol		
Salicyaldehyde		
m- and p-cresol		
Five*		
2-n-propylphenol		
2,3,5 trimethylphenol		
2,3,5,6 tetramethylphenol		

*Five = p-ethylphenol; 2-isopropylphenol; 2,3-xylenol; 3,5-xylenol; 2,4,6 trimethylphenol

TABLE C-13. FTP INDIVIDUAL SAMPLE UNREGULATED EMISSIONS RESULTS

H-Coal Naphtha Blend EM-543-F

Test 864

	Emissions in mg/km	
	Cold-UDDS	Hot-UDDS
Total Particulates	56.43	16.27
Sulfate		
Aldehydes & Ketones		
Formaldehyde	0.00	0.00
Acetaldehyde	0.00	0.00
Acetone	0.00	0.00
Methyl ethyl ketone	0.00	0.00
Hexanaldehyde	0.00	0.00

	Emissions in ppm			
	Cold-UDDS		Hot-UDDS	
	1	2	3	4
Individual Hydrocarbons				
Methane	3.29	1.46	2.14	1.35
Ethylene	2.90	0.10	0.53	0.00
Ethane	0.80	0.29	0.57	0.34
Acetylene	0.66	0.00	0.00	0.00
Propane	0.00	0.00	0.00	0.00
Propylene	1.81	0.00	0.20	0.00
Benzene	1.43	0.18	0.48	0.00
Toluene	2.74	0.00	0.31	0.00

APPENDIX D

Computer Printouts of the Regulated Emissions Test Results

Table D-	Test No.	Fuel	Fuel Code
1-3	851-3	Base	EM-338-F
4-5	854-5	Mobil "MTG"	EM-486-F
6-7	856-7	Simulated Coal	EM-468-F
8-9	858-9	EDS Naphtha Blend	EM-488-F
10	860	Base	EM-338-F
11-12	861-2	Sasol Blend	EM-542-F
13-14	863-4	H-Coal Naphtha Blend	EM-543-F

TABLE D-1. TEST NO. 851 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -
PROJECT 05-5830-011

TEST NO. 851FTP RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 11/20/81
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-338-F
ODOMETER 12793. KM(7949. MILES)

BAROMETER 751.59 MM HG(29.59 IN HG)
RELATIVE HUMIDITY 27. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 5.7 GM/KG

NOX HUMIDITY CORRECTION FACTOR .86

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.8 (109.0)	41.7 (107.0)	42.2 (108.0)	41.7 (107.0)
BLOWER REVOLUTIONS	40453.	69561.	40425.	69476.
TOT FLOW STD. CU. METRES(SCF)	76.7 (2709.)	132.2 (4668.)	76.7 (2710.)	132.0 (4662.)
THC SAMPLE METER/RANGE/PPM	38.6/ 2/ 39.	10.4/ 2/ 10.	16.9/ 2/ 17.	8.4/ 2/ 8.
THC BCKGRD METER/RANGE/PPM	10.6/ 2/ 11.	9.4/ 2/ 9.	8.2/ 2/ 8.	7.5/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	77.9/12/ 183.	5.2/13/ 5.	10.4/13/ 9.	3.7/13/ 3.
CO BCKGRD METER/RANGE/PPM	2.7/12/ 5.	4.2/13/ 4.	2.7/13/ 2.	2.3/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	58.5/ 3/1.0332	37.4/ 3/ .6297	53.1/ 3/ .9272	37.0/ 3/ .6223
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .0428	2.9/ 3/ .0444	2.9/ 3/ .0444	3.0/ 3/ .0459
NOX SAMPLE METER/RANGE/PPM	9.7/ 2/ 9.7	2.8/ 2/ 2.8	3.7/ 2/ 3.7	3.1/ 2/ 3.1
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ .3	.2/ 2/ .2	.2/ 2/ .2	.2/ 2/ .2
DILUTION FACTOR	12.70	21.23	14.41	21.49
THC CONCENTRATION PPM	29.	1.	9.	1.
CO CONCENTRATION PPM	173.	1.	7.	1.
CO2 CONCENTRATION PCT	.9938	.5874	.8859	.5785
NOX CONCENTRATION PPM	9.4	2.6	3.5	2.9
THC MASS GRAMS	1.28	.11	.41	.10
CO MASS GRAMS	15.43	.16	.62	.20
CO2 MASS GRAMS	1396.0	1421.6	1244.8	1398.5
NOX MASS GRAMS	1.19	.57	.44	.63
THC GRAMS/KM	.22	.02	.07	.02
CO GRAMS/KM	2.66	.02	.11	.03
CO2 GRAMS/KM	240.8	227.1	215.3	223.6
NOX GRAMS/KM	.20	.09	.08	.10
FUEL CONSUMPTION BY CB L/100KM	10.49	9.70	9.21	9.55
RUN TIME SECONDS	504.	868.	505.	868.
MEASURED DISTANCE KM	5.80	6.26	5.78	6.25
SCF, DRY	.982	.985	.983	.985
DFC, WET (DRY)	.984 .941(.933)		.984 .945(.937)	
TOT VOL (SCM) / SAM BLR (SCM)	208.9/ 0.00		208.8/ 0.00	
KM (MEASURED)	12.06		12.04	
FUEL CONSUMPTION L/100KM	10.08		9.38	

COMPOSITE RESULTS

TEST NUMBER		851FTP
BAROMETER	MM HG	751.6
HUMIDITY	G/KG	5.7
TEMPERATURE	DEG C	25.6

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	226.7	(225.7)
FUEL CONSUMPTION	L/100KM	9.73	(9.68)
HYDROCARBONS (THC)	G/KM	.07	(.07)
CARBON MONOXIDE	G/KM	.59	(.59)
OXIDES OF NITROGEN	G/KM	.11	(.11)

HFET - VEHICLE EMISSIONS RESULTS -
PROJECT 05-5830-011

TEST NO. 851FET RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 11/20/81
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-338-F
ODOMETER 12817. KM(7964. MILES)

BAROMETER 751.59 MM HG(29.59 IN HG)
RELATIVE HUMIDITY 26. PCT
DRY BULB TEMP. 26.7 DEG C(80.0 DEG F)
ABS. HUMIDITY 5.8 GM/KG

NOX HUMIDITY CORRECTION FACTOR .86

BAG RESULTS

TEST CYCLE	HFET
BLOWER DIF P MM. H2O(IN. H2O)	789.9 (31.1)
BLOWER INLET P MM. H2O(IN. H2O)	789.9 (31.1)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)
BLOWER REVOLUTIONS	61178.
TOT FLOW STD. CU. METRES(SCF)	117.9 (4163.)
THC SAMPLE METER/RANGE/PPM	22.4/ 2/ 22.
THC BCKGRD METER/RANGE/PPM	6.9/ 2/ 7.
CO SAMPLE METER/RANGE/PPM	96.2/13/ 98.
CO BCKGRD METER/RANGE/PPM	2.2/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	75.9/ 3/1.3850
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .0428
NOX SAMPLE METER/RANGE/PPM	3.9/ 2/ 3.9
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ .4
DILUTION FACTOR	9.59
THC CONCENTRATION PPM	16.
CO CONCENTRATION PPM	92.
CO2 CONCENTRATION PCT	1.3466
NOX CONCENTRATION PPM	3.5
THC MASS GRAMS	1.10
CO MASS GRAMS	12.70
CO2 MASS GRAMS	2906.9
NOX MASS GRAMS	.69
RUN TIME SECONDS	765.
DFC, WET (DRY)	.896 (.888)
SCF, WET (DRY)	1.000 (.979)
VOL (SCM)	117.9
SAM BLR (SCM)	0.00
KM (MEASURED)	16.37

TEST NUMBER,		851FET
BAROMETER,	MM HG	751.6
HUMIDITY,	G/KG	5.8
TEMPERATURE,	DEG C	26.7
CARBON DIOXIDE,	G/KM	177.5
FUEL CONSUMPTION,	L/100KM	7.64
HYDROCARBONS, (THC)	G/KM	.07
CARBON MONOXIDE,	G/KM	.78
OXIDES OF NITROGEN,	G/KM	.04

TABLE D-2. TEST NO. 852 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -
PROJECT 05-5830-011

TEST NO. 852FTP RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 11/23/81
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-338-F
ODOMETER 12845. KM(7982. MILES)

BAROMETER 739.65 MM HG(29.12 IN HG)
RELATIVE HUMIDITY 57. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 12.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.04

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	784.9 (30.9)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	784.9 (30.9)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)	41.7 (107.0)	41.1 (106.0)	42.2 (108.0)
BLOWER REVOLUTIONS	40465.	69556.	40447.	69418.
TOT FLOW STD. CU. METRES(SCF)	75.7 (2672.)	130.2 (4598.)	75.8 (2676.)	129.9 (4585.)
THC SAMPLE METER/RANGE/PPM	37.9/ 2/ 38.	9.4/ 2/ 9.	17.9/ 2/ 18.	9.1/ 2/ 9.
THC BCKGRD METER/RANGE/PPM	9.7/ 2/ 10.	9.4/ 2/ 9.	8.9/ 2/ 9.	9.2/ 2/ 9.
CO SAMPLE METER/RANGE/PPM	86.7/12/ 210.	4.1/13/ 4.	16.2/13/ 15.	4.7/13/ 4.
CO BCKGRD METER/RANGE/PPM	.5/12/ 1.	1.1/13/ 1.	1.6/13/ 1.	1.3/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	61.4/ 3/1.0908	39.3/ 3/ .6647	55.0/ 3/ .9643	38.9/ 3/ .6573
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .0444	2.8/ 3/ .0428	3.0/ 3/ .0459	3.1/ 3/ .0474
NOX SAMPLE METER/RANGE/PPM	8.6/ 2/ 8.6	1.7/ 2/ 1.7	3.1/ 2/ 3.1	.9/ 2/ .9
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ .5	.5/ 2/ .5	.5/ 2/ .5	.6/ 2/ .6
DILUTION FACTOR	12.02	20.12	13.85	20.34
THC CONCENTRATION PPM	29.	0.	10.	0.
CO CONCENTRATION PPM	201.	3.	13.	3.
CO2 CONCENTRATION PCT	1.0502	.6240	.9217	.6122
NOX CONCENTRATION PPM	8.1	1.2	2.6	.3
THC MASS GRAMS	1.27	.04	.42	.03
CO MASS GRAMS	17.73	.40	1.13	.46
CO2 MASS GRAMS	1455.0	1487.6	1278.9	1455.5
NOX MASS GRAMS	1.23	.32	.40	.09
THC GRAMS/KM	.22	.01	.07	.00
CO GRAMS/KM	3.07	.06	.20	.07
CO2 GRAMS/KM	252.1	239.7	220.1	231.6
NOX GRAMS/KM	.21	.05	.07	.01
FUEL CONSUMPTION BY CB L/100KM	11.00	10.24	9.42	9.89
RUN TIME SECONDS	505.	868.	505.	867.
MEASURED DISTANCE KM	5.77	6.21	5.81	6.29
SCF, DRY	.972	.974	.973	.975 .976
DFC, WET (DRY)		.938(.921)		.942(.925)
TOT VOL (SCM) / SAM BLR (SCM)		205.9/ 0.00		205.6/ 0.00
KM (MEASURED)		11.98		12.09
FUEL CONSUMPTION L/100KM		10.60		9.66

COMPOSITE RESULTS

TEST NUMBER		852FTP
BAROMETER	MM HG	739.6
HUMIDITY	G/KG	12.0
TEMPERATURE	DEG C	25.6

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	236.9	(234.5)
FUEL CONSUMPTION	L/100KM	10.17	(10.07)
HYDROCARBONS (THC)	G/KM	.07	(.07)
CARBON MONOXIDE	G/KM	.72	(.73)
OXIDES OF NITROGEN	G/KM	.09	(.08)

HFET - VEHICLE EMISSIONS RESULTS -
PROJECT 05-5830-011

TEST NO. 852FET RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 11/23/81
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-338-F
ODOMETER 12870. KM(7997. MILES)

BAROMETER 739.14 MM HG(29.10 IN HG)
RELATIVE HUMIDITY 49. PCT
DRY BULB TEMP. 27.8 DEG C(82.0 DEG F)
ABS. HUMIDITY 11.8 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.04

BAG RESULTS

TEST CYCLE	HFET
BLOWER DIF P MM. H2O(IN. H2O)	800.1 (31.5)
BLOWER INLET P MM. H2O(IN. H2O)	800.1 (31.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.8 (109.0)
BLOWER REVOLUTIONS	61199.
TOT FLOW STD. CU. METRES(SCF)	116.0 (4095.)
THC SAMPLE METER/RANGE/PPM	24.1/ 2/ 24.
THC BCKGRD METER/RANGE/PPM	9.1/ 2/ 9.
CO SAMPLE METER/RANGE/PPM	48.5/12/ 102.
CO BCKGRD METER/RANGE/PPM	.5/12/ 1.
CO2 SAMPLE METER/RANGE/PCT	79.6/ 3/1.4614
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .0428
NOX SAMPLE METER/RANGE/PPM	4.0/ 2/ 4.0
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ .5
DILUTION FACTOR	9.09
THC CONCENTRATION PPM	16.
CO CONCENTRATION PPM	97.
CO2 CONCENTRATION PCT	1.4233
NOX CONCENTRATION PPM	3.6
THC MASS GRAMS	1.07
CO MASS GRAMS	13.09
CO2 MASS GRAMS	3022.1
NOX MASS GRAMS	.82
RUN TIME SECONDS	765.
DFC, WET (DRY)	.890 (.876)
SCF, WET (DRY)	1.000 (.971)
VOL (SCM)	116.0
SAM BLR (SCM)	0.00
KM (MEASURED)	16.40
TEST NUMBER,	851FET
BAROMETER, MM HG	739.1
HUMIDITY, G/KG	11.8
TEMPERATURE, DEG C	27.8
CARBON DIOXIDE, G/KM	184.2
FUEL CONSUMPTION, L/100KM	7.93
HYDROCARBONS, (THC) G/KM	.07
CARBON MONOXIDE, G/KM	.80
OXIDES OF NITROGEN, G/KM	.05

TABLE D-3. TEST NO. 853 EMISSIONS RESULTS

TEST NO. 853FTP RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

BAROMETER 743.46 MM HG(29.27 IN HG)
RELATIVE HUMIDITY 43. PCT
BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H20(IN. H20)	787.4 (31.0)	784.9 (30.9)	784.9 (30.9)	784.9 (30.9)
BLOWER INLET P MM. H20(IN. H20)	787.4 (31.0)	784.9 (30.9)	784.9 (30.9)	784.9 (30.9)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.8 (109.0)	42.2 (108.0)	42.8 (109.0)	42.2 (108.0)
BLOWER REVOLUTIONS	40477.	69577.	40398.	69501.
TOT FLOW STD. CU. METRES(SCF)	76.2 (2690.)	131.1 (4630.)	76.1 (2685.)	131.0 (4625.)
THC SAMPLE METER/RANGE/PPM	41.6/ 2/ 42.	10.6/ 2/ 11.	12.4/ 2/ 12.	9.4/ 2/ 9.
THC BCKGRD METER/RANGE/PPM	10.8/ 2/ 11.	10.4/ 2/ 10.	9.9/ 2/ 10.	9.7/ 2/ 10.
CO SAMPLE METER/RANGE/PPM	89.1/12/ 218.	4.6/13/ 4.	10.6/13/ 10.	4.7/13/ 4.
CO BCKGRD METER/RANGE/PPM	1.8/12/ 3.	3.0/13/ 3.	2.3/13/ 2.	2.1/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	59.4/ 3/1.0510	38.0/ 3/ .6407	53.2/ 3/ .9291	37.4/ 3/ .6297
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .0444	2.9/ 3/ .0444	3.0/ 3/ .0459	3.4/ 3/ .0521
NOX SAMPLE METER/RANGE/PPM	7.7/ 2/ 7.7	2.6/ 2/ 2.6	3.7/ 2/ 3.7	.8/ 2/ .8
NOX BCKGRD METER/RANGE/PPM	.2/ 2/ .2	.3/ 2/ .3	.3/ 2/ .3	.7/ 2/ .7
DILUTION FACTOR	12.45	20.87	14.39	21.24
THC CONCENTRATION PPM	32.	1.	3.	0.
CO CONCENTRATION PPM	208.	9.	7.	2.
CO2 CONCENTRATION PCT	1.0102	.5985	.8864	.5800
NOX CONCENTRATION PPM	7.5	2.5	3.4	.1
THC MASS GRAMS	1.39	.05	.14	.01
CO MASS GRAMS	18.43	.23	.65	.36
CO2 MASS GRAMS	1409.0	1436.7	1234.3	1390.8
NOX MASS GRAMS	1.04	.55	.47	.03
THC GRAMS/KM	.24	.01	.02	.00
CO GRAMS/KM	3.19	.04	.11	.06
CO2 GRAMS/KM	244.0	230.4	213.8	222.1
NOX GRAMS/KM	.18	.09	.08	.01
FUEL CONSUMPTION BY CB L/100KM	10.66	9.84	9.14	9.48
RUN TIME SECONDS	504.	868.	504.	868.
MEASURED DISTANCE KM	5.78	6.24	5.77	6.26
SCF, DRY	.976	.980	.977	.980
DFC, WET (DRY)	.979		.979	
TOT VOL (SCM) / SAM BLR (SCM)	.940(.927)		.945(.932)	
KM (MEASURED)	207.3/ 0.00		207.0/ 0.00	
FUEL CONSUMPTION L/100KM	12.01		12.04	
	10.23		9.32	

FTP - VEHICLE EMISSIONS RESULTS -
PROJECT 05-5830-011

VEHICLE NO.85
DATE 11/24/81
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-338-F
ODOMETER 12887. KM(8008. MILES)

DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 9.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .95

COMPOSITE RESULTS

		853FTP	3-BAG	(4-BAG)
TEST NUMBER				
BAROMETER	MM HG	743.5		
HUMIDITY	G/KG	9.0		
TEMPERATURE	DEG C	25.6		
CARBON DIOXIDE	G/KM		228.6	(226.2)
FUEL CONSUMPTION	L/100KM		9.81	(9.71)
HYDROCARBONS (THC)	G/KM		.06	(.06)
CARBON MONOXIDE	G/KM		.71	(.72)
OXIDES OF NITROGEN	G/KM		.11	(.08)

TEST NO. 853FET RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

BAROMETER 743.71 MM HG(29.28 IN HG)
RELATIVE HUMIDITY 44. PCT
BAG RESULTS

TEST CYCLE	HFET
BLOWER DIF P MM. H20(IN. H20)	800.1 (31.5)
BLOWER INLET P MM. H20(IN. H20)	800.1 (31.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.8 (109.0)
BLOWER REVOLUTIONS	61205.
TOT FLOW STD. CU. METRES(SCF)	116.8 (4126.)
THC SAMPLE METER/RANGE/PPM	21.5/ 2/ 22.
THC BCKGRD METER/RANGE/PPM	7.8/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	93.5/13/ 95.
CO BCKGRD METER/RANGE/PPM	1.3/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	76.0/ 3/1.3871
CO2 BCKGRD METER/RANGE/PCT	2.6/ 3/ .0397
NOX SAMPLE METER/RANGE/PPM	2.7/ 2/ 2.7
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ .7
DILUTION FACTOR	9.58
THC CONCENTRATION PPM	15.
CO CONCENTRATION PPM	90.
CO2 CONCENTRATION PCT	1.3515
NOX CONCENTRATION PPM	2.1
THC MASS GRAMS	.98
CO MASS GRAMS	12.20
CO2 MASS GRAMS	2891.0
NOX MASS GRAMS	.44
RUN TIME SECONDS	765.
DFC, WET (DRY)	.896 (.883)
SCF, WET (DRY)	1.000 (.973)
VOL (SCM)	116.8
SAM BLR (SCM)	0.00
KM (MEASURED)	16.31

HFET - VEHICLE EMISSIONS RESULTS -
PROJECT 05-5830-011

VEHICLE NO.85
DATE 11/24/81
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-338-F
ODOMETER 12911. KM(8023. MILES)

DRY BULB TEMP. 26.1 DEG C(79.0 DEG F)
ABS. HUMIDITY 9.5 GM/KG

NOX HUMIDITY CORRECTION FACTOR .96

		853FET
TEST NUMBER,		
BAROMETER,	MM HG	743.7
HUMIDITY,	G/KG	9.5
TEMPERATURE,	DEG C	26.1
CARBON DIOXIDE,	G/KM	177.3
FUEL CONSUMPTION,	L/100KM	7.63
HYDROCARBONS, (THC)	G/KM	.06
CARBON MONOXIDE,	G/KM	.75
OXIDES OF NITROGEN,	G/KM	.03

TABLE D-4. TEST NO. 854 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -EM-486-F
PROJECT 05-4493-001

TEST NO. 854 RUN 2
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 2/ 8/82
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-486-F
ODOMETER 14373. KM(8931. MILES)

BAROMETER 741.68 MM HG(29.20 IN HG)
RELATIVE HUMIDITY 32. PCT
BAG RESULTS

DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 6.3 GM/KG

NOX HUMIDITY CORRECTION FACTOR .87

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	40432.	69569.	40405.	69591.
TOT FLOW STD. CU. METRES(SCF)	75.8 (2678.)	130.5 (4608.)	75.8 (2676.)	130.5 (4606.)
HC SAMPLE METER/RANGE/PPM	37.2/ 2/ 37.	10.3/ 2/ 10.	11.6/ 2/ 12.	9.3/ 2/ 9.
HC BCKGRD METER/RANGE/PPM	10.1/ 2/ 10.	9.5/ 2/ 10.	9.1/ 2/ 9.	9.0/ 2/ 9.
CO SAMPLE METER/RANGE/PPM	79.6/12/ 188.	7.3/13/ 7.	11.7/13/ 11.	9.3/13/ 9.
CO BCKGRD METER/RANGE/PPM	2.3/12/ 4.	4.0/13/ 4.	2.8/13/ 3.	2.5/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	58.6/ 3/ 1.04	38.2/ 3/ .64	53.0/ 3/ .93	37.0/ 3/ .62
CO2 BCKGRD METER/RANGE/PCT	3.2/ 3/ .05	2.8/ 3/ .04	3.3/ 3/ .05	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	14.0/ 2/ 14.	5.0/ 2/ 5.	7.1/ 2/ 7.	3.4/ 2/ 3.
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ 1.	.5/ 2/ 1.	.4/ 2/ 0.	.4/ 2/ 0.
DILUTION FACTOR	12.60	20.61	14.36	21.39
HC CONCENTRATION PPM	28.	1.	3.	1.
CO CONCENTRATION PPM	178.	3.	8.	3.
CO2 CONCENTRATION PCT	.99	.60	.88	.58
NOX CONCENTRATION PPM	13.5	4.5	6.7	3.0
HC MASS GRAMS	1.22	.10	.14	.09
CO MASS GRAMS	15.73	.46	.70	.39
CO2 MASS GRAMS	1374.8	1442.2	1218.5	1389.3
NOX MASS GRAMS	1.71	.99	.85	.66
HC GRAMS/KM	.21	.02	.02	.01
CO GRAMS/KM	2.70	.07	.12	.06
CO2 GRAMS/KM	236.3	231.4	209.4	221.0
NOX GRAMS/KM	.29	.16	.15	.10
FUEL CONSUMPTION BY CB L/100KM	10.32	9.91	8.97	9.46
RUN TIME SECONDS	504.	868.	504.	868.
MEASURED DISTANCE KM	5.82	6.23	5.82	6.27
SCF, DRY	.980 .982	.984	.981 .983	.984
DFC, WET (DRY)	.940(.930)		.949(.935)	
TOT VOL (SCM) / SAM BLR (SCM)	206.3/ 0.00		206.2/ 0.00	
KM (MEASURED)	12.05		12.09	
FUEL CONSUMPTION L/100KM	10.11		9.22	

COMPOSITE RESULTS

TEST NUMBER		854
BAROMETER	MM HG	741.7
HUMIDITY	G/KG	6.3
TEMPERATURE	DEG C	24.4

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	226.4	(223.3)
FUEL CONSUMPTION	L/100KM	9.73	(9.60)
HYDROCARBONS (THC)	G/KM	.06	(.06)
CARBON MONOXIDE	G/KM	.63	(.63)
OXIDES OF NITROGEN	G/KM	.18	(.17)

HFET - VEHICLE EMISSIONS RESULTS -EM-486-F
PROJECT 05-4493-001

TEST NO. 854 RUN 2
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 2/ 8/82
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-486-F
ODOMETER 14397. KM(8946. MILES)

BAROMETER 741.17 MM HG(29.18 IN HG)
RELATIVE HUMIDITY 33. PCT
BAG RESULTS

DRY BULB TEMP. 25.0 DEG C(77.0 DEG F)
ABS. HUMIDITY 6.7 GM/KG

NOX HUMIDITY CORRECTION FACTOR .88

TEST CYCLE	HFET
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.8 (109.0)
BLOWER REVOLUTIONS	61162.
TOT FLOW STD. CU. METRES(SCF)	116.5 (4114.)
HC SAMPLE METER/RANGE/PPM	15.4/ 2/ 15.
HC BCKGRD METER/RANGE/PPM	8.6/ 2/ 9.
CO SAMPLE METER/RANGE/PPM	58.2/13/ 56.
CO BCKGRD METER/RANGE/PPM	1.9/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	77.1/ 3/ 1.41
CO2 BCKGRD METER/RANGE/PCT	3.5/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	4.5/ 2/ 5.
NOX BCKGRD METER/RANGE/PPM	.4/ 2/ 0.
DILUTION FACTOR	9.40
HC CONCENTRATION PPM	8.
CO CONCENTRATION PPM	52.
CO2 CONCENTRATION PCT	1.36
NOX CONCENTRATION PPM	4.1
HC MASS GRAMS	.52
CO MASS GRAMS	7.05
CO2 MASS GRAMS	2904.9
NOX MASS GRAMS	.81
RUN TIME SECONDS	764.
DFC, WET (DRY),	.894 (.884)
SCF, WET (DRY)	1.000 (.976)
VOL (SCM)	116.5
SAM BLR (SCM)	0.00
KM (MEASURED)	16.36
TEST NUMBER,	854
BAROMETER, MM HG	741.2
HUMIDITY, G/KG	6.7
TEMPERATURE, DEG C	25.0
CARBON DIOXIDE, G/KM	177.5
FUEL CONSUMPTION, L/100KM	7.63
HYDROCARBONS, G/KM	.03
CARBON MONOXIDE, G/KM	.43
OXIDES OF NITROGEN, G/KM	.05

TABLE D-5. TEST NO. 855 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -
PROJECT 05-4493-001

TEST NO. 855 RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 1/29/82
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-486-F
ODOMETER 13849. KM(8605. MILES)

BAROMETER 738.89 MM HG(29.09 IN HG)
RELATIVE HUMIDITY 57. PCT
DRY BULB TEMP. 25.6 DEG C(78.0 DEG F)
ABS. HUMIDITY 12.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR 1.04

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	784.9 (30.9)	784.9 (30.9)	784.9 (30.9)	784.9 (30.9)
BLOWER INLET P MM. H2O(IN. H2O)	784.9 (30.9)	784.9 (30.9)	784.9 (30.9)	784.9 (30.9)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	40381.	69424.	40351.	69448.
TOT FLOW STD. CU. METRES(SCF)	75.4 (2661.)	129.6 (4575.)	75.3 (2659.)	129.6 (4576.)
HC SAMPLE METER/RANGE/PPM	51.1/ 2/ 51.	19.3/ 2/ 19.	21.2/ 2/ 21.	19.8/ 2/ 20.
HC BCKGRD METER/RANGE/PPM	21.7/ 2/ 22.	20.7/ 2/ 21.	19.8/ 2/ 20.	20.1/ 2/ 20.
CO SAMPLE METER/RANGE/PPM	88.8/12/ 217.	3.9/13/ 4.	12.6/13/ 11.	5.0/13/ 5.
CO BCKGRD METER/RANGE/PPM	.2/12/ 0.	.6/13/ 1.	.6/13/ 1.	.5/13/ 0.
CO2 SAMPLE METER/RANGE/PCT	59.0/ 3/ 1.04	37.7/ 3/ .64	53.8/ 3/ .94	39.7/ 3/ .60
CO2 BCKGRD METER/RANGE/PCT	2.3/ 3/ .04	2.5/ 3/ .04	3.0/ 3/ .05	1.8/ 3/ .03
NOX SAMPLE METER/RANGE/PPM	8.9/ 2/ 9.	2.1/ 2/ 2.	4.1/ 2/ 4.	1.2/ 2/ 1.
NOX BCKGRD METER/RANGE/PPM	.1/ 2/ 0.	.2/ 2/ 0.	.2/ 2/ 0.	.4/ 2/ 0.
DILUTION FACTOR	12.46	20.89	14.11	22.16
HC CONCENTRATION PPM	31.	-0.	3.	1.
CO CONCENTRATION PPM	209.	3.	10.	4.
CO2 CONCENTRATION PCT	1.01	.60	.90	.57
NOX CONCENTRATION PPM	8.8	1.9	3.9	.8
HC MASS GRAMS	1.36	-.03	.12	.05
CO MASS GRAMS	18.30	.44	.92	.60
CO2 MASS GRAMS	1394.6	1420.3	1238.3	1357.9
NOX MASS GRAMS	1.32	.49	.59	.21
HC GRAMS/KM	.24	-.00	.02	.01
CO GRAMS/KM	3.19	.07	.16	.10
CO2 GRAMS/KM	243.5	227.1	215.1	218.1
NOX GRAMS/KM	.23	.08	.10	.03
FUEL CONSUMPTION BY CB L/100KM	10.66	9.72	9.13	9.34
RUN TIME SECONDS	504.	867.	504.	868.
MEASURED DISTANCE KM	5.73	6.25	5.81	6.23
SCF, DRY	.972 .974	.976	.973 .975	.976
DFC, WET (DRY)	.940(.923)		.945(.928)	
TOT VOL (SCM) / SAM BLR (SCM)	204.9/ 0.00		204.9/ 0.00	
KM (MEASURED)	11.98		12.04	
FUEL CONSUMPTION L/100KM	10.17		9.24	

COMPOSITE RESULTS

TEST NUMBER		855
BAROMETER	MM HG	738.9
HUMIDITY	G/KG	12.0
TEMPERATURE	DEG C	25.6

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	226.6	(223.9)
FUEL CONSUMPTION	L/100KM	9.75	(9.64)
HYDROCARBONS (THC)	G/KM	.05	(.06)
CARBON MONOXIDE	G/KM	.74	(.74)
OXIDES OF NITROGEN	G/KM	.12	(.10)

TABLE D-6. TEST NO. 856 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -EN-468-F
PROJECT 05-4493-001

TEST NO. 856 RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 2/ 9/82
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-468-F
ODOMETER 14458. KM(8984. MILES)

BAROMETER 747.52 MM HG(29.43 IN HG)
RELATIVE HUMIDITY 26. PCT
BAG RESULTS

DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
ABS. HUMIDITY 4.5 GM/KG

NOX HUMIDITY CORRECTION FACTOR .83

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	42.2 (108.0)
BLOWER REVOLUTIONS	40456.	69568.	40406.	69480.
TOT FLOW STD. CU. METRES(SCF)	76.4 (2699.)	131.4 (4641.)	76.3 (2695.)	131.5 (4644.)
HC SAMPLE METER/RANGE/PPM	35.9/ 2/ 36.	6.8/ 2/ 7.	8.2/ 2/ 8.	6.3/ 2/ 6.
HC BCKGRD METER/RANGE/PPM	6.6/ 2/ 7.	6.4/ 2/ 6.	5.5/ 2/ 6.	5.8/ 2/ 6.
CO SAMPLE METER/RANGE/PPM	87.2/13/ 87.	4.1/13/ 4.	11.3/13/ 10.	6.9/13/ 6.
CO BCKGRD METER/RANGE/PPM	.8/12/ 1.	1.1/13/ 1.	.6/13/ 1.	2.6/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	58.1/ 3/ 1.03	37.0/ 3/ .62	51.8/ 3/ .90	35.3/ 3/ .59
CO2 BCKGRD METER/RANGE/PCT	2.7/ 3/ .04	3.0/ 3/ .05	2.6/ 3/ .04	2.5/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	13.3/ 2/ 13.	2.7/ 2/ 3.	5.4/ 2/ 5.	1.4/ 2/ 1.
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ 0.	.2/ 2/ 0.	.2/ 2/ 0.	.3/ 2/ 0.
DILUTION FACTOR	13.20	21.97	15.16	23.12
HC CONCENTRATION PPM	30.	1.	3.	1.
CO CONCENTRATION PPM	84.	3.	9.	4.
CO2 CONCENTRATION PCT	.99	.58	.86	.55
NOX CONCENTRATION PPM	13.0	2.5	5.2	1.1
HC MASS GRAMS	1.30	.05	.13	.06
CO MASS GRAMS	7.43	.41	.84	.59
CO2 MASS GRAMS	1381.3	1391.9	1208.6	1335.4
NOX MASS GRAMS	1.58	.52	.63	.23
HC GRAMS/KM	.23	.01	.02	.01
CO GRAMS/KM	1.28	.07	.15	.10
CO2 GRAMS/KM	238.4	224.7	209.8	214.8
NOX GRAMS/KM	.27	.08	.11	.04
FUEL CONSUMPTION BY CB L/100KM	9.88	9.21	8.61	8.81
RUN TIME SECONDS	504.	868.	504.	868.
MEASURED DISTANCE KM	5.79	6.20	5.76	6.22
SCF, DRY	.983 .985	.986	.984 .985	.986
DFC, WET (DRY)	.943(.935)		.948(.940)	
TOT VOL (SCM) / SAM BLR (SCM)	207.9/ 0.00		207.8/ 0.00	
KM (MEASURED)	11.99		11.98	
FUEL CONSUMPTION L/100KM	9.53		8.71	

COMPOSITE RESULTS
TEST NUMBER 856
BAROMETER MM HG 747.5
HUMIDITY G/KG 4.5
TEMPERATURE DEG C 22.8

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	223.4	(220.5)
FUEL CONSUMPTION	L/100KM	9.18	(9.07)
HYDROCARBONS (THC)	G/KM	.06	(.06)
CARBON MONOXIDE	G/KM	.34	(.35)
OXIDES OF NITROGEN	G/KM	.13	(.12)

HFET - VEHICLE EMISSIONS RESULTS -EN-468-F
PROJECT 05-4493-001

TEST NO. 856 RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 2/ 9/82
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-468-F
ODOMETER 14482. KM(8999. MILES)

BAROMETER 748.54 MM HG(29.47 IN HG)
RELATIVE HUMIDITY 19. PCT
BAG RESULTS

DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 3.5 GM/KG

NOX HUMIDITY CORRECTION FACTOR .81

TEST CYCLE	HFET
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)
BLOWER REVOLUTIONS	61219.
TOT FLOW STD. CU. METRES(SCF)	117.6 (4151.)
HC SAMPLE METER/RANGE/PPM	15.4/ 2/ 15.
HC BCKGRD METER/RANGE/PPM	5.9/ 2/ 6.
CO SAMPLE METER/RANGE/PPM	76.2/13/ 75.
CO BCKGRD METER/RANGE/PPM	2.5/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	76.0/ 3/ 1.39
CO2 BCKGRD METER/RANGE/PCT	2.5/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	7.3/ 2/ 7.
NOX BCKGRD METER/RANGE/PPM	.5/ 2/ 1.
DILUTION FACTOR	9.81
HC CONCENTRATION PPM	10.
CO CONCENTRATION PPM	71.
CO2 CONCENTRATION PCT	1.35
NOX CONCENTRATION PPM	6.9
HC MASS GRAMS	.68
CO MASS GRAMS	9.65
CO2 MASS GRAMS	2911.9
NOX MASS GRAMS	1.25
RUN TIME SECONDS	765.
DFC, WET (DRY)	.898 (.893)
SCF, WET (DRY)	1.000 (.982)
VOL (SCM)	117.6
SAM BLR (SCM)	0.00
KM (MEASURED)	15.67
TEST NUMBER,	856
BAROMETER, MM HG	748.5
HUMIDITY, G/KG	3.5
TEMPERATURE, DEG C	23.9
CARBON DIOXIDE, G/KM	185.8
FUEL CONSUMPTION, L/100KM	7.66
HYDROCARBONS, G/KM	.04
CARBON MONOXIDE, G/KM	.62
OXIDES OF NITROGEN, G/KM	.08

TABLE D-7. TEST NO. 857 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -EM-468-F
PROJECT 05-4493-001

TEST NO. 857 RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 2/10/82
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-468-F
ODOMETER 14499. KM(9009. MILES)

BAROMETER 747.01 MM HG(29.41 IN HG)
RELATIVE HUMIDITY 18. PCT
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 3.2 GM/KG

NOX HUMIDITY CORRECTION FACTOR .80

BAG RESULTS

BAG NUMBER	1	2	3	4
DESCRIPTION	COLD TRANSIENT	STABILIZED	HOT TRANSIENT	STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	40565.	69438.	40394.	69514.
TOT FLOW STD. CU. METRES(SCF)	76.3 (2696.)	130.7 (4614.)	76.0 (2684.)	130.8 (4619.)
HC SAMPLE METER/RANGE/PPM	48.3/ 2/ 48.	8.6/ 2/ 9.	12.5/ 2/ 13.	9.1/ 2/ 9.
HC BCKGRD METER/RANGE/PPM	7.8/ 2/ 8.	7.8/ 2/ 8.	7.7/ 2/ 8.	8.2/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	83.3/13/ 85.	8.6/13/ 8.	17.6/13/ 16.	7.7/13/ 7.
CO BCKGRD METER/RANGE/PPM	2.4/12/ 4.	4.5/13/ 4.	3.1/13/ 3.	2.7/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	58.8/ 3/ 1.04	38.0/ 3/ .64	52.0/ 3/ .91	35.9/ 3/ .60
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .04	3.2/ 3/ .05	3.1/ 3/ .05	2.9/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	14.9/ 2/ 15.	2.2/ 2/ 2.	8.2/ 2/ 8.	2.3/ 2/ 2.
NOX BCKGRD METER/RANGE/PPM	.3/ 2/ 0.	.4/ 2/ 0.	.3/ 2/ 0.	.4/ 2/ 0.
DILUTION FACTOR	13.02	21.32	15.07	22.69
HC CONCENTRATION PPM	41.	1.	5.	1.
CO CONCENTRATION PPM	77.	4.	13.	5.
CO2 CONCENTRATION PCT	1.00	.59	.86	.56
NOX CONCENTRATION PPM	14.6	1.8	7.9	1.9
HC MASS GRAMS	1.80	.09	.23	.09
CO MASS GRAMS	6.82	.58	1.15	.69
CO2 MASS GRAMS	1395.3	1421.2	1199.0	1340.6
NOX MASS GRAMS	1.71	.36	.92	.38
HC GRAMS/KM	.31	.01	.04	.02
CO GRAMS/KM	1.18	.09	.20	.11
CO2 GRAMS/KM	241.4	229.3	207.9	214.7
NOX GRAMS/KM	.30	.06	.16	.06
FUEL CONSUMPTION BY CB L/100KM	10.01	9.40	8.53	8.81
RUN TIME SECONDS	506.	867.	504.	869.
MEASURED DISTANCE KM	5.78	6.20	5.77	6.24
SCF, DRY	.985	.989	.986	.989
DFC, WET (DRY)	.987		.988	
TOT VOL (SCM) / SAM BLR (SCM)	.942(.937)		.948(.942)	
KM (MEASURED)	207.0/ 0.00		206.8/ 0.00	
FUEL CONSUMPTION L/100KM	11.98		12.01	
	9.69		8.68	

COMPOSITE RESULTS
TEST NUMBER 857
BAROMETER MM HG 747.0
HUMIDITY G/KG 3.2
TEMPERATURE DEG C 23.3

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	225.9	(221.6)
FUEL CONSUMPTION	L/100KM	9.29	(9.11)
HYDROCARBONS (THC)	G/KM	.08	(.08)
CARBON MONOXIDE	G/KM	.35	(.35)
OXIDES OF NITROGEN	G/KM	.14	(.14)

TABLE D-8. TEST NO. 858 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -EDS NAPHTHA BLEND
PROJECT 05-4493-001

TEST NO. 858 RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 3/ 5/82
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-488-F
ODOMETER 15796. KM(9815. MILES)

BAROMETER 736.60 MM HG(29.00 IN HG)
RELATIVE HUMIDITY 28. PCT
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 5.4 GM/KG

NOX HUMIDITY CORRECTION FACTOR .85

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)	40.6 (105.0)	42.2 (108.0)	41.7 (107.0)
BLOWER REVOLUTIONS	40676.	69470.	40490.	69350.
TOT FLOW STD. CU. METRES(SCF)	75.8 (2677.)	129.9 (4586.)	75.5 (2665.)	129.8 (4582.)
HC SAMPLE METER/RANGE/PPM	44.8/ 2/ 45.	12.1/ 2/ 12.	16.2/ 2/ 16.	10.9/ 2/ 11.
HC BCKGRD METER/RANGE/PPM	11.4/ 2/ 11.	10.0/ 2/ 10.	9.0/ 2/ 9.	8.3/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	82.4/12/ 197.	8.0/13/ 7.	34.4/13/ 32.	10.7/13/ 10.
CO BCKGRD METER/RANGE/PPM	.5/12/ 1.	.9/13/ 1.	.7/13/ 1.	.7/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	55.6/ 3/ .98	37.3/ 3/ .63	51.8/ 3/ .90	36.6/ 3/ .61
CO2 BCKGRD METER/RANGE/PCT	3.1/ 3/ .05	3.1/ 3/ .05	2.7/ 3/ .04	3.0/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	17.5/ 2/ 18.	3.8/ 2/ 4.	9.7/ 2/ 10.	2.9/ 2/ 3.
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1.	.8/ 2/ 1.	.7/ 2/ 1.	.6/ 2/ 1.
DILUTION FACTOR	13.29	21.09	14.65	21.53
HC CONCENTRATION PPM	34.	3.	8.	3.
CO CONCENTRATION PPM	190.	6.	30.	9.
CO2 CONCENTRATION PCT	.93	.58	.86	.57
NOX CONCENTRATION PPM	16.8	3.0	9.0	2.3
HC MASS GRAMS	1.52	.20	.35	.20
CO MASS GRAMS	16.79	.95	2.67	1.34
CO2 MASS GRAMS	1294.0	1385.5	1193.1	1357.0
NOX MASS GRAMS	2.07	.64	1.11	.49
HC GRAMS/KM	.26	.03	.06	.03
CO GRAMS/KM	2.89	.15	.46	.21
CO2 GRAMS/KM	222.5	219.4	204.7	214.5
NOX GRAMS/KM	.36	.10	.19	.08
FUEL CONSUMPTION BY CB L/100KM	9.67	9.32	8.73	9.12
RUN TIME SECONDS	507.	867.	505.	868.
MEASURED DISTANCE KM	5.82	6.32	5.83	6.33
SCF, DRY	.982 .984	.985	.982 .984	.985
DFC, WET (DRY)	.942(.934)		.946(.937)	
TOT VOL (SCM) / SAM BLR (SCM)	205.7/ 0.00		205.2/ 0.00	
KM (MEASURED)	12.13		12.15	
FUEL CONSUMPTION L/100KM	9.49		8.93	

COMPOSITE RESULTS

TEST NUMBER 858
BAROMETER MM HG 736.6
HUMIDITY G/KG 5.4
TEMPERATURE DEG C 23.9

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	216.0	(214.6)
FUEL CONSUMPTION	L/100KM	9.23	(9.17)
HYDROCARBONS (THC)	G/KM	.09	(.09)
CARBON MONOXIDE	G/KM	.80	(.82)
OXIDES OF NITROGEN	G/KM	.18	(.17)

HFET - VEHICLE EMISSIONS RESULTS -EDS NAPHTHA BLEND
PROJECT 05-4493-001

TEST NO. 858 RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 3/ 9/82
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-488-F
ODOMETER 15820. KM(9830. MILES)

BAROMETER 737.11 MM HG(29.02 IN HG)
RELATIVE HUMIDITY 29. PCT
DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 5.7 GM/KG

NOX HUMIDITY CORRECTION FACTOR .86

BAG RESULTS

TEST CYCLE	HFET
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.2 (108.0)
BLOWER REVOLUTIONS	61243.
TOT FLOW STD. CU. METRES(SCF)	116.0 (4096.)
HC SAMPLE METER/RANGE/PPM	25.4/ 2/ 25.
HC BCKGRD METER/RANGE/PPM	8.0/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	82.6/12/ 197.
CO BCKGRD METER/RANGE/PPM	.2/12/ 0.
CO2 SAMPLE METER/RANGE/PCT	73.9/ 3/ 1.34
CO2 BCKGRD METER/RANGE/PCT	2.8/ 3/ .04
NOX SAMPLE METER/RANGE/PPM	9.1/ 2/ 9.
NOX BCKGRD METER/RANGE/PPM	.6/ 2/ 1.
DILUTION FACTOR	9.73
HC CONCENTRATION PPM	18.
CO CONCENTRATION PPM	190.
CO2 CONCENTRATION PCT	1.31
NOX CONCENTRATION PPM	8.6
HC MASS GRAMS	1.24
CO MASS GRAMS	25.64
CO2 MASS GRAMS	2772.5
NOX MASS GRAMS	1.63
RUN TIME SECONDS	765.
DFC, WET (DRY)	.897 (.889)
SCF, WET (DRY)	1.000 (.978)
VOL (SCM)	116.0
SAM BLR (SCM)	0.00
KM (MEASURED)	16.42
TEST NUMBER,	858
BAROMETER, MM HG	737.1
HUMIDITY, G/KG	5.7
TEMPERATURE, DEG C	24.4
CARBON DIOXIDE, G/KM	168.9
FUEL CONSUMPTION, L/100KM	7.28
HYDROCARBONS, G/KM	.08
CARBON MONOXIDE, G/KM	1.56
OXIDES OF NITROGEN, G/KM	.10

TABLE D-9. TEST NO. 859 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS -EDS NAPHTHA BLEND
PROJECT 05-4493-001

TEST NO. 859 RUN 1
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 3/ 8/82
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-488-F
ODOMETER 15849. KM(9848. MILES)

BAROMETER 748.03 MM HG(29.45 IN HG)
RELATIVE HUMIDITY 33. PCT
DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 6.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .87

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET P MM. H2O(IN. H2O)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)	787.4 (31.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	42.8 (109.0)	41.7 (107.0)	42.2 (108.0)	41.7 (107.0)
BLOWER REVOLUTIONS	40514.	69589.	40422.	69528.
TOT FLOW STD. CU. METRES(SCF)	76.1 (2686.)	130.9 (4623.)	76.0 (2682.)	130.8 (4618.)
HC SAMPLE METER/RANGE/PPM	45.6/ 2/ 46.	13.5/ 2/ 14.	16.2/ 2/ 16.	11.8/ 2/ 12.
HC BCKGRD METER/RANGE/PPM	13.3/ 2/ 13.	11.6/ 2/ 12.	10.3/ 2/ 10.	9.3/ 2/ 9.
CO SAMPLE METER/RANGE/PPM	81.0/12/ 192.	10.2/13/ 9.	31.7/13/ 29.	15.7/13/ 14.
CO BCKGRD METER/RANGE/PPM	1.6/12/ 3.	2.7/13/ 2.	1.8/13/ 2.	1.5/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	58.1/ 3/ 1.03	38.1/ 3/ .64	52.5/ 3/ .92	37.3/ 3/ .63
CO2 BCKGRD METER/RANGE/PCT	3.4/ 3/ .05	3.0/ 3/ .05	3.4/ 3/ .05	3.4/ 3/ .05
NOX SAMPLE METER/RANGE/PPM	19.0/ 2/ 19.	3.4/ 2/ 3.	8.5/ 2/ 9.	2.2/ 2/ 2.
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ 1.	.7/ 2/ 1.	.6/ 2/ 1.	.6/ 2/ 1.
DILUTION FACTOR	12.67	20.60	14.44	21.07
HC CONCENTRATION PPM	33.	2.	7.	3.
CO CONCENTRATION PPM	184.	7.	27.	13.
CO2 CONCENTRATION PCT	.98	.60	.87	.58
NOX CONCENTRATION PPM	18.3	2.7	7.9	1.6
HC MASS GRAMS	1.49	.19	.29	.23
CO MASS GRAMS	16.25	1.02	2.38	1.92
CO2 MASS GRAMS	1361.1	1435.4	1205.9	1384.5
NOX MASS GRAMS	2.30	.59	1.00	.35
HC GRAMS/KM	.26	.03	.05	.04
CO GRAMS/KM	2.80	.16	.41	.31
CO2 GRAMS/KM	234.7	230.9	208.7	222.1
NOX GRAMS/KM	.40	.10	.17	.06
FUEL CONSUMPTION BY CB L/100KM	10.18	9.81	8.89	9.45
RUN TIME SECONDS	505.	868.	505.	868.
MEASURED DISTANCE KM	5.80	6.22	5.78	6.23
SCF, DRY	.979	.983	.980	.983
DFC, WET (DRY)	.982		.982	
TOT VOL (SCM) / SAM BLR (SCM)	.940(.930)		.945(.934)	
KM (MEASURED)	207.0/ 0.00		206.8/ 0.00	
FUEL CONSUMPTION L/100KM	12.02		12.01	
	9.99		9.18	

COMPOSITE RESULTS

TEST NUMBER		859
BAROMETER	MM HG	748.0
HUMIDITY	G/KG	6.0
TEMPERATURE	DEG C	23.3

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	225.6	(223.0)
FUEL CONSUMPTION	L/100KM	9.64	(9.53)
HYDROCARBONS (THC)	G/KM	.08	(.08)
CARBON MONOXIDE	G/KM	.78	(.82)
OXIDES OF NITROGEN	G/KM	.18	(.17)

TABLE D-10. TEST NO. 860 EMISSIONS RESULTS

```
TEST NO.   860      RUN   1
VEHICLE MODEL   81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

BAROMETER 742.70 MM HG(29.24 IN HG)
RELATIVE HUMIDITY  25. PCT
BAG RESULTS
   BAG NUMBER
   DESCRIPTION

   BLOWER DIF P MM. H2O(IN. H2O)
   BLOWER INLET P MM. H2O(IN. H2O)
   BLOWER INLET TEMP. DEG. C(DEG. F)
   BLOWER REVOLUTIONS
   TOT FLOW STD. CU. METRES(SCF)
   THC SAMPLE METER/RANGE/PPM
   THC BCKGRD METER/RANGE/PPM
   CO  SAMPLE METER/RANGE/PPM
   CO  BCKGRD METER/RANGE/PPM
   CO2 SAMPLE METER/RANGE/PCT
   CO2 BCKGRD METER/RANGE/PCT
   NOX SAMPLE METER/RANGE/PPM
   NOX BCKGRD METER/RANGE/PPM
   DILUTION FACTOR
   THC CONCENTRATION PPM
   CO  CONCENTRATION PPM
   CO2 CONCENTRATION PCT
   NOX CONCENTRATION PPM
   THC MASS GRAMS
   CO  MASS GRAMS
   CO2 MASS GRAMS
   NOX MASS GRAMS

   THC  GRAMS/KM
   CO   GRAMS/KM
   CO2  GRAMS/KM
   NOX  GRAMS/KM
   FUEL CONSUMPTION BY CB L/100KM

   RUN TIME                SECONDS
   MEASURED DISTANCE       KM
   SCF, DRY
        DFC, WET (DRY)
        TOT VOL (SCM) / SAM BLR (SCM)
        KM  (MEASURED)
        FUEL CONSUMPTION L/100KM

COMPOSITE RESULTS
   TEST NUMBER          860
   BAROMETER    MM HG  742.7
   HUMIDITY     G/KG     4.7
   TEMPERATURE  DEG C   23.9
```

CFTP - VEHICLE EMISSIONS RESULTS - EM-338-F
PROJECT 05-4493-001

```
VEHICLE NO.85                          TEST WEIGHT  1134. KG( 2500. LBS)
DATE    2/18/83                        ACTUAL ROAD LOAD   5.7 KW(  7.7 HP)
BAG CART NO. 1 / CVS NO.  2            GASOLINE  EM-338-F
DYNO NO.     3                         ODOMETER 16377. KM(10176. MILES)

DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY  4.7 GM/KG               NOX HUMIDITY CORRECTION FACTOR   .84
```

1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
812.8 (32.0)	812.8 (32.0)	812.8 (32.0)	812.8 (32.0)
812.8 (32.0)	812.8 (32.0)	812.8 (32.0)	812.8 (32.0)
39.4 (103.0)	40.6 (105.0)	41.7 (107.0)	39.4 (103.0)
40483.	69335.	40521.	69306.
75.4 (2662.)	128.9 (4550.)	75.2 (2654.)	129.1 (4558.)
39.8/ 2/ 40.	7.8/ 2/ 8.	14.7/ 2/ 15.	8.4/ 2/ 8.
6.9/ 2/ 7.	6.2/ 2/ 6.	6.3/ 2/ 6.	6.7/ 2/ 7.
87.3/12/ 212.	5.3/13/ 5.	17.8/13/ 16.	4.9/13/ 4.
1.2/12/ 2.	1.7/13/ 2.	1.6/13/ 1.	1.8/13/ 2.
99.1/11/ .9703	68.3/11/ .3916	87.9/11/ .8561	68.1/11/ .3892
6.7/11/ .0400	6.6/11/ .0394	6.7/11/ .0400	6.8/11/ .0406
23.5/ 2/ 23.5	4.5/ 2/ 4.5	12.2/ 2/ 12.2	3.3/ 2/ 3.3
.5/ 2/ .5	.6/ 2/ .6	.6/ 2/ .6	.6/ 2/ .6
13.47	22.60	15.60	22.69
33.	2.	9.	2.
205.	3.	14.	3.
.9333	.5540	.8187	.5504
23.0	3.9	11.6	2.7
1.45	.14	.38	.15
17.96	.49	1.26	.42
1288.3	1306.9	1126.5	1300.5
2.77	.81	1.40	.56
.25	.02	.07	.02
3.15	.08	.22	.07
226.1	213.6	197.5	212.2
.49	.13	.24	.09
9.90	9.13	8.45	9.06
506.	867.	506.	868.
5.70	6.12	5.70	6.13
.983 .985	.986	.984 .986	.986
.945(.937)		.949(.941)	
204.3/ 0.00		204.2/ 0.00	
11.82		11.83	
9.50		8.77	

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	211.8	(211.4)
FUEL CONSUMPTION	L/100KM	9.10	(9.08)
HYDROCARBONS (THC)	G/KM	.08	(.08)
CARBON MONOXIDE	G/KM	.76	(.75)
OXIDES OF NITROGEN	G/KM	.24	(.22)

```
TEST NO.   860      RUN   1
VEHICLE MODEL   81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

BAROMETER 740.92 MM HG(29.17 IN HG)
RELATIVE HUMIDITY  26. PCT
BAG RESULTS
   TEST CYCLE

   BLOWER DIF P MM. H2O(IN. H2O)
   BLOWER INLET P MM. H2O(IN. H2O)
   BLOWER INLET TEMP. DEG. C(DEG. F)
   BLOWER REVOLUTIONS
   TOT FLOW STD. CU. METRES(SCF)
   THC SAMPLE METER/RANGE/PPM
   THC BCKGRD METER/RANGE/PPM
   CO  SAMPLE METER/RANGE/PPM
   CO  BCKGRD METER/RANGE/PPM
   CO2 SAMPLE METER/RANGE/PCT
   CO2 BCKGRD METER/RANGE/PCT
   NOX SAMPLE METER/RANGE/PPM
   NOX BCKGRD METER/RANGE/PPM
   DILUTION FACTOR
   THC CONCENTRATION PPM
   CO  CONCENTRATION PPM
   CO2 CONCENTRATION PCT
   NOX CONCENTRATION PPM
   THC MASS GRAMS
   CO  MASS GRAMS
   CO2 MASS GRAMS
   NOX MASS GRAMS
   RUN TIME                SECONDS
        DFC, WET (DRY)
        SCF, WET (DRY)
        VOL (SCM)
        SAM BLR (SCM)
        KM  (MEASURED)

   TEST NUMBER,
   BAROMETER,              MM HG
   HUMIDITY,               G/KG
   TEMPERATURE,            DEG C
   CARBON DIOXIDE,          G/KM
   FUEL CONSUMPTION,        L/100KM

   HYDROCARBONS, (THC)     G/KM
   CARBON MONOXIDE,        G/KM
   OXIDES OF NITROGEN,     G/KM
```

HFET - VEHICLE EMISSIONS RESULTS - EM-338-F
PROJECT 05-4493-001

```
VEHICLE NO.85                          TEST WEIGHT  1134. KG( 2500. LBS)
DATE    2/18/83                        ACTUAL ROAD LOAD   5.7 KW(  7.7 HP)
BAG CART NO.  1                        GASOLINE  EM-338-F
DYNO NO.      3                        ODOMETER 16385. KM(10181. MILES)
CVS NO.   2

DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY  5.1 GM/KG               NOX HUMIDITY CORRECTION FACTOR   .84
```

HFET
812.8 (32.0)
812.8 (32.0)
42.2 (108.0)
61241.
113.2 (3995.)
21.7/ 2/ 22.
7.9/ 2/ 8.
63.4/13/ 61.
3.2/13/ 3.
75.1/ 3/1.3685
2.6/ 3/ .0397
7.7/ 2/ 7.7
.7/ 2/ .7
9.73
15.
56.
1.3329
7.1
.95
7.43
2761.2
1.29
767.
.897 (.890)
1.000 (.979)
113.2
0.00
16.60
860
740.9
5.1
24.4
166.4
7.14
.06
.45
.08

TABLE D-11. TEST NO. 861 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS - EM-542-F
PROJECT 05-4493-001

TEST NO. 861 RUN
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 2/21/83
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-542-F
ODOMETER 16441. KM(10216. MILES)

BAROMETER 740.66 MM HG(29.16 IN HG)
RELATIVE HUMIDITY 27. PCT
BAG RESULTS

DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 5.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .84

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	825.5 (32.5)	825.5 (32.5)	825.5 (32.5)	825.5 (32.5)
BLOWER INLET P MM. H2O(IN. H2O)	825.5 (32.5)	825.5 (32.5)	825.5 (32.5)	825.5 (32.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)	43.3 (110.0)
BLOWER REVOLUTIONS	40641.	69424.	40467.	69350.
TOT FLOW STD. CU. METRES(SCF)	74.8 (2641.)	127.7 (4511.)	74.5 (2629.)	127.6 (4506.)
THC SAMPLE METER/RANGE/PPM	52.3/ 2/ 52.	13.6/ 2/ 14.	25.4/ 2/ 25.	13.5/ 2/ 14.
THC BCKGRD METER/RANGE/PPM	9.0/ 2/ 9.	7.9/ 2/ 8.	7.9/ 2/ 8.	7.7/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	96.2/12/ 242.	5.7/13/ 5.	35.1/13/ 32.	5.6/13/ 5.
CO BCKGRD METER/RANGE/PPM	.6/12/ 1.	1.3/13/ 1.	1.4/13/ 1.	1.0/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	96.2/11/ .9888	68.4/11/ .5928	88.4/11/ .8637	67.4/11/ .5808
CO2 BCKGRD METER/RANGE/PCT	6.9/11/ .0412	6.8/11/ .0406	6.8/11/ .0406	6.8/11/ .0406
NOX SAMPLE METER/RANGE/PPM	37.9/ 2/ 37.9	11.6/ 2/ 11.6	29.1/ 2/ 29.1	11.5/ 2/ 11.5
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ .7	.8/ 2/ .8	.9/ 2/ .9	.9/ 2/ .9
DILUTION FACTOR	12.92	22.11	15.12	22.56
THC CONCENTRATION PPM	44.	6.	18.	6.
CO CONCENTRATION PPM	235.	4.	30.	4.
CO2 CONCENTRATION PCT	.9507	.5540	.8257	.5420
NOX CONCENTRATION PPM	37.3	10.8	28.3	10.6
THC MASS GRAMS	1.92	.45	.78	.46
CO MASS GRAMS	20.42	.58	2.64	.61
CO2 MASS GRAMS	1301.7	1295.7	1125.7	1266.1
NOX MASS GRAMS	4.48	2.23	3.38	2.18
THC GRAMS/KM	.33	.07	.14	.07
CO GRAMS/KM	3.47	.09	.46	.10
CO2 GRAMS/KM	221.5	208.4	195.8	204.0
NOX GRAMS/KM	.76	.36	.59	.35
FUEL CONSUMPTION BY CB L/100KM	9.95	9.11	8.60	8.92
RUN TIME SECONDS	507.	868.	506.	867.
MEASURED DISTANCE KM	5.88	6.22	5.75	6.21
SCF, DRY	.982	.984	.983	.985 .986
DFC, WET (DRY)		.943(.935)		.948(.939)
TOT VOL (SCM) / SAM BLR (SCM)		202.5/ 0.00		202.1/ 0.00
KM (MEASURED)		12.10		11.95
FUEL CONSUMPTION L/100KM		9.52		8.76

COMPOSITE RESULTS
TEST NUMBER 861
BAROMETER MM HG 740.7
HUMIDITY G/KG 5.0
TEMPERATURE DEG C 23.3

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	207.7	(206.4)
FUEL CONSUMPTION	L/100KM	9.14	(9.09)
HYDROCARBONS (THC)	G/KM	.14	(.14)
CARBON MONOXIDE	G/KM	.90	(.90)
OXIDES OF NITROGEN	G/KM	.51	(.50)

FET - VEHICLE EMISSIONS RESULTS - EM-542-F
PROJECT 05-4493-001

TEST NO. 861 RUN
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 2/21/83
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-542-F
ODOMETER 16465. KM(10231. MILES)

DRY BULB TEMP. 23.3 DEG C(74.0 DEG F)
ABS. HUMIDITY 5.0 GM/KG

NOX HUMIDITY CORRECTION FACTOR .84

BAROMETER 740.16 MM HG(29.14 IN HG)
RELATIVE HUMIDITY 27. PCT
BAG RESULTS

TEST CYCLE	FET
BLOWER DIF P MM. H2O(IN. H2O)	825.5 (32.5)
BLOWER INLET P MM. H2O(IN. H2O)	825.5 (32.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	43.3 (110.0)
BLOWER REVOLUTIONS	61157.
TOT FLOW STD. CU. METRES(SCF)	112.4 (3970.)
THC SAMPLE METER/RANGE/PPM	24.1/ 2/ 24.
THC BCKGRD METER/RANGE/PPM	7.7/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	57.3/13/ 55.
CO BCKGRD METER/RANGE/PPM	.9/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	72.0/ 3/1.3050
CO2 BCKGRD METER/RANGE/PCT	2.5/ 3/ .0382
NOX SAMPLE METER/RANGE/PPM	17.4/ 2/ 17.4
NOX BCKGRD METER/RANGE/PPM	1.0/ 2/ 1.0
DILUTION FACTOR	10.01
THC CONCENTRATION PPM	17.
CO CONCENTRATION PPM	52.
CO2 CONCENTRATION PCT	1.2706
NOX CONCENTRATION PPM	16.5
THC MASS GRAMS	1.12
CO MASS GRAMS	6.81
CO2 MASS GRAMS	2615.6
NOX MASS GRAMS	2.98
RUN TIME SECONDS	765.
DFC, WET (DRY)	.900 (.892)
SCF, WET (DRY)	1.000 (.978)
VOL (SCM)	112.4
SAM BLR (SCM)	0.00
KM (MEASURED)	16.40
TEST NUMBER,	861
BAROMETER, MM HG	740.2
HUMIDITY, G/KG	5.0
TEMPERATURE, DEG C	23.3
CARBON DIOXIDE, G/KM	159.5
FUEL CONSUMPTION, L/100KM	7.00
HYDROCARBONS, (THC) G/KM	.07
CARBON MONOXIDE, G/KM	.42
OXIDES OF NITROGEN, G/KM	.18

TABLE D-12. TEST NO. 862 EMISSIONS RESULTS

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FTP   - VEHICLE EMISSIONS RESULTS - EM-542-F
        PROJECT 05-4493-001

TEST NO.   862       RUN
VEHICLE MODEL    81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

BAROMETER 740.41 MM HG(29.15 IN HG)
RELATIVE HUMIDITY  33. PCT
BAG RESULTS
   BAG NUMBER
   DESCRIPTION

   BLOWER DIF P MM. H2O(IN. H2O)
   BLOWER INLET P MM. H2O(IN. H2O)
   BLOWER INLET TEMP. DEG. C(DEG. F)
   BLOWER REVOLUTIONS
   TOT FLOW STD. CU. METRES(SCF)
   THC SAMPLE METER/RANGE/PPM
   THC BCKGRD METER/RANGE/PPM
   CO  SAMPLE METER/RANGE/PPM
   CO  BCKGRD METER/RANGE/PPM
   CO2 SAMPLE METER/RANGE/PCT
   CO2 BCKGRD METER/RANGE/PCT
   NOX SAMPLE METER/RANGE/PPM
   NOX BCKGRD METER/RANGE/PPM
   DILUTION FACTOR
   THC CONCENTRATION PPM
   CO  CONCENTRATION PPM
   CO2 CONCENTRATION PCT
   NOX CONCENTRATION PPM
   THC MASS GRAMS
   CO  MASS GRAMS
   CO2 MASS GRAMS
   NOX MASS GRAMS

   THC  GRAMS/KM
   CO   GRAMS/KM
   CO2  GRAMS/KM
   NOX  GRAMS/KM
   FUEL CONSUMPTION BY CB L/100KM

   RUN TIME                SECONDS
   MEASURED DISTANCE       KM
   SCF, DRY
        DFC, WET (DP")
        TOT VOL (SCM) / SAM BLR (SCM)
        KM  (MEASURED)
        FUEL CONSUMPTION L/100KM

COMPOSITE RESULTS
   TEST NUMBER          862
   BAROMETER     MM HG  740.4
   HUMIDITY      G/KG     5.8
   TEMPERATURE   DEG C   22.8

VEHICLE NO.85
DATE    2/22/83
BAG CART NO. 1 / CVS NO.  2
DYNO NO.      3

DRY BULB TEMP. 22.8 DEG C(73.0 DEG F)
ABS. HUMIDITY  5.8 GM/KG

TEST WEIGHT  1134. KG( 2500. LBS)
ACTUAL ROAD LOAD   5.7 KW(  7.7 HP)
GASOLINE  EM-542-F
ODOMETER 16486. KM(10244. MILES)

NOX HUMIDITY CORRECTION FACTOR    .86

          1                  2                  3                  4
  COLD TRANSIENT      STABILIZED         HOT TRANSIENT      STABILIZED

  825.5 (32.5)       825.5 (32.5)       825.5 (32.5)       825.5 (32.5)
  825.5 (32.5)       825.5 (32.5)       825.5 (32.5)       825.5 (32.5)
   43.3 (110.0)       43.3 (110.0)       43.3 (110.0)       43.3 (110.0)
    40622.             69454.             40455.             69345.
   74.7 ( 2639.)      127.8 ( 4511.)      74.4 ( 2627.)      127.5 ( 4504.)
 55.9/ 2/  56.      12.1/ 2/  12.     25.9/ 2/  26.      12.5/ 2/  13.
  6.8/ 2/   7.       6.5/ 2/   7.      6.3/ 2/   6.       6.2/ 2/   6.
 62.6/11/ 251.      9.7/13/   5.     37.1/13/  34.       5.5/13/   5.
   .4/11/   1.       .9/13/   1.      .7/13/   1.       .5/13/   0.
 96.6/11/ .9955    68.4/11/ .5928    88.7/11/ .8682    67.2/11/ .5784
  6.8/11/ .0406     6.8/11/ .0406     6.8/11/ .0406     6.8/11/ .0406
 37.8/ 2/ 37.8     38.8/ 1/ 11.5     32.2/ 2/ 32.2     36.8/ 1/ 10.9
   .4/ 2/   .4      1.4/ 1/   .4      .4/ 2/   .4      1.0/ 1/   .3
    12.82              22.11             15.04              22.66
    50.                 6.                20.                 7.
   242.                 4.                33.                 4.
  .9581              .5940              .8303              .5396
   37.4               11.1               31.8               10.7
    2.16               .44                .87                .49
   21.06               .63               2.85               .66
 1310.8             1295.8             1131.2             1259.9
    4.60               2.34              3.90               2.24

    .38                .07               .15                .08
   3.66               .10                .30                .11
  227.8              209.7              198.0              204.3
    .80                .38               .68                .36
  10.24               9.17              8.70               8.93

  507.               867.               505.               867.
 5.76               6.18               5.71               6.17
 .980               .984               .981               .984
        .982                                  .983
      .943( .933)                           .948( .938)
    202.5/  0.00                          202.0/  0.00
      11.94                                 11.88
       9.68                                  8.82

                                                    3-BAG          (4-BAG)
CARBON DIOXIDE          G/KM                       210.2          ( 208.7)
FUEL CONSUMPTION        L/100KM                      9.26         (  9.19)
HYDROCARBONS (THC)      G/KM                         .16          (   .16)
CARBON MONOXIDE         G/KM                         .95          (   .95)
OXIDES OF NITROGEN      G/KM                         .55          (   .54)
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TABLE D-13. TEST NO. 863 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS - EM-543-F
PROJECT 05-4493-001

TEST NO. 863 RUN
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 3/ 1/83
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-543-F
ODOMETER 17072. KM(10608. MILES)

BAROMETER 740.41 MM HG(29.15 IN HG)
RELATIVE HUMIDITY 48. PCT
DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 9.1 GM/KG

NOX HUMIDITY CORRECTION FACTOR .95

BAG RESULTS

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	812.8 (32.0)	825.5 (32.5)	812.8 (32.0)	825.5 (32.5)
BLOWER INLET P MM. H2O(IN. H2O)	812.8 (32.0)	812.8 (32.0)	812.8 (32.0)	812.8 (32.0)
BLOWER INLET TEMP. DEG. C(DEG. F)	44.4 (112.0)	42.2 (108.0)	43.9 (111.0)	42.8 (109.0)
BLOWER REVOLUTIONS	40461.	69520.	40354.	69424.
TOT FLOW STD. CU. METRES(SCF)	74.4 (2628.)	128.3 (4531.)	74.3 (2623.)	128.0 (4520.)
THC SAMPLE METER/RANGE/PPM	70.6/ 2/ 71.	16.2/ 2/ 16.	23.0/ 2/ 23.	15.4/ 2/ 15.
THC BCKGRD METER/RANGE/PPM	13.1/ 2/ 13.	13.3/ 2/ 13.	13.2/ 2/ 13.	12.9/ 2/ 13.
CO SAMPLE METER/RANGE/PPM	67.3/11/ 278.	19.2/13/ 17.	45.0/13/ 42.	33.7/13/ 31.
CO BCKGRD METER/RANGE/PPM	.9/11/ 3.	2.8/13/ 3.	2.9/13/ 3.	2.5/13/ 2.
CO2 SAMPLE METER/RANGE/PCT	98.5/ 3/1.0332	73.3/11/ .6536	92.2/11/ .9229	71.5/11/ .6309
CO2 BCKGRD METER/RANGE/PCT	4.1/ 3/ .0629	10.5/11/ .0643	10.0/11/ .0610	9.7/11/ .0590
NOX SAMPLE METER/RANGE/PPM	28.7/ 2/ 28.7	21.4/ 1/ 6.4	73.6/ 1/ 21.9	31.3/ 1/ 9.3
NOX BCKGRD METER/RANGE/PPM	.8/ 2/ .8	2.7/ 1/ .8	3.0/ 1/ .9	2.6/ 1/ .8
DILUTION FACTOR	12.45	20.23	14.30	20.91
THC CONCENTRATION PPM	59.	4.	11.	3.
CO CONCENTRATION PPM	266.	15.	38.	28.
CO2 CONCENTRATION PCT	.9753	.5926	.8662	.5747
NOX CONCENTRATION PPM	28.0	5.6	21.1	8.6
THC MASS GRAMS	2.55	.27	.47	.23
CO MASS GRAMS	23.04	2.18	3.32	4.19
CO2 MASS GRAMS	1329.0	1392.0	1178.2	1346.8
NOX MASS GRAMS	3.78	1.31	2.84	1.99
THC GRAMS/KM	.44	.04	.08	.04
CO GRAMS/KM	4.00	.35	.58	.68
CO2 GRAMS/KM	231.0	224.5	204.4	217.3
NOX GRAMS/KM	.66	.21	.49	.32
FUEL CONSUMPTION BY CB L/100KM	9.99	9.43	8.61	9.15
RUN TIME SECONDS	504.	868.	504.	868.
MEASURED DISTANCE KM	5.75	6.20	5.76	6.20
SCF, DRY	.975	.978	.976	.979
DFC, WET (DRY)	.977		.978	
TOT VOL (SCM) / SAM BLR (SCM)	.939(.925)		.944(.929)	
KM (MEASURED)	202.7/ 0.00		202.3/ 0.00	
FUEL CONSUMPTION L/100KM	11.95		11.96	
	9.70		8.89	

COMPOSITE RESULTS

TEST NUMBER		863
BAROMETER	MM HG	740.4
HUMIDITY	G/KG	9.1
TEMPERATURE	DEG C	23.9

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	220.3	(218.2)
FUEL CONSUMPTION	L/100KM	9.32	(9.24)
HYDROCARBONS (THC)	G/KM	.14	(.13)
CARBON MONOXIDE	G/KM	1.17	(1.27)
OXIDES OF NITROGEN	G/KM	.38	(.41)

FET - VEHICLE EMISSIONS RESULTS - EM-543-F
PROJECT 05-4493-001

TEST NO. 863 RUN
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

VEHICLE NO.85
DATE 3/ 1/83
BAG CART NO. 1
DYNO NO. 3
CVS NO. 2

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-543-F
ODOMETER 17094. KM(10622. MILES)

BAROMETER 740.41 MM HG(29.15 IN HG)
RELATIVE HUMIDITY 42. PCT
DRY BULB TEMP. 24.4 DEG C(76.0 DEG F)
ABS. HUMIDITY 8.2 GM/KG

NOX HUMIDITY CORRECTION FACTOR .92

BAG RESULTS

TEST CYCLE	FET
BLOWER DIF P MM. H2O(IN. H2O)	825.5 (32.5)
BLOWER INLET P MM. H2O(IN. H2O)	825.5 (32.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	44.4 (112.0)
BLOWER REVOLUTIONS	61207.
TOT FLOW STD. CU. METRES(SCF)	112.4 (3967.)
THC SAMPLE METER/RANGE/PPM	25.2/ 2/ 25.
THC BCKGRD METER/RANGE/PPM	11.8/ 2/ 12.
CO SAMPLE METER/RANGE/PPM	52.3/12/ 112.
CO BCKGRD METER/RANGE/PPM	1.0/12/ 2.
CO2 SAMPLE METER/RANGE/PCT	74.0/ 3/1.3459
CO2 BCKGRD METER/RANGE/PCT	3.3/ 3/ .0505
NOX SAMPLE METER/RANGE/PPM	70.7/ 1/ 21.0
NOX BCKGRD METER/RANGE/PPM	3.0/ 1/ .9
DILUTION FACTOR	9.78
THC CONCENTRATION PPM	15.
CO CONCENTRATION PPM	106.
CO2 CONCENTRATION PCT	1.3006
NOX CONCENTRATION PPM	20.2
THC MASS GRAMS	.96
CO MASS GRAMS	13.81
CO2 MASS GRAMS	2675.4
NOX MASS GRAMS	4.01
RUN TIME SECONDS	766.
DFC, WET (DRY)	.898 (.886)
SCF, WET (DRY)	1.000 (.974)
VOL (SCM)	112.4
SAM BLR (SCM)	0.00
KM (MEASURED)	16.34

TEST NUMBER,		863
BAROMETER,	MM HG	740.4
HUMIDITY,	G/KG	8.2
TEMPERATURE,	DEG C	24.4
CARBON DIOXIDE,	G/KM	163.7
FUEL CONSUMPTION,	L/100KM	6.92
HYDROCARBONS, (THC)	G/KM	.06
CARBON MONOXIDE,	G/KM	.84
OXIDES OF NITROGEN,	G/KM	.25

TABLE D-14. TEST NO. 864 EMISSIONS RESULTS

FTP - VEHICLE EMISSIONS RESULTS - EM-543-F
PROJECT 05-4493-001

TEST NO. 864 RUN
VEHICLE MODEL 81 VW RABBIT
ENGINE 1.7 L(105. CID) L-4
TRANSMISSION A3

BAROMETER 732.03 MM HG(28.82 IN HG)
RELATIVE HUMIDITY 52. PCT
BAG RESULTS

VEHICLE NO.85
DATE 3/ 3/83
BAG CART NO. 1 / CVS NO. 2
DYNO NO. 3

TEST WEIGHT 1134. KG(2500. LBS)
ACTUAL ROAD LOAD 5.7 KW(7.7 HP)
GASOLINE EM-543-F
ODOMETER 17123. KM(10640. MILES)

DRY BULB TEMP. 23.9 DEG C(75.0 DEG F)
ABS. HUMIDITY 9.9 GM/KG

NOX HUMIDITY CORRECTION FACTOR .97

BAG NUMBER / DESCRIPTION	1 COLD TRANSIENT	2 STABILIZED	3 HOT TRANSIENT	4 STABILIZED
BLOWER DIF P MM. H2O(IN. H2O)	812.8 (32.0)	812.8 (32.0)	812.8 (32.0)	812.8 (32.0)
BLOWER INLET P MM. H2O(IN. H2O)	800.1 (31.5)	812.8 (32.0)	800.1 (31.5)	800.1 (31.5)
BLOWER INLET TEMP. DEG. C(DEG. F)	44.4 (112.0)	45.6 (114.0)	44.4 (112.0)	43.3 (110.0)
BLOWER REVOLUTIONS	40677.	69588.	40457.	69468.
TOT FLOW STD. CU. METRES(SCF)	74.0 (2612.)	126.6 (4470.)	73.6 (2598.)	126.6 (4469.)
THC SAMPLE METER/RANGE/PPM	47.7/ 2/ 48.	12.4/ 2/ 12.	19.6/ 2/ 20.	11.2/ 2/ 11.
THC BCKGRD METER/RANGE/PPM	7.9/ 2/ 8.	7.7/ 2/ 8.	8.0/ 2/ 8.	7.6/ 2/ 8.
CO SAMPLE METER/RANGE/PPM	96.0/12/ 242.	64.7/13/ 62.	83.4/13/ 83.	54.8/13/ 52.
CO BCKGRD METER/RANGE/PPM	.9/12/ 2.	1.7/13/ 2.	1.3/13/ 1.	1.5/13/ 1.
CO2 SAMPLE METER/RANGE/PCT	58.5/ 3/1.0332	72.1/11/ .6384	92.0/11/ .9198	70.4/11/ .6172
CO2 BCKGRD METER/RANGE/PCT	2.9/ 3/ .0444	6.8/11/ .0406	6.8/11/ .0406	6.8/11/ .0406
NOX SAMPLE METER/RANGE/PPM	32.6/ 2/ 32.6	41.1/ 1/ 12.2	86.6/ 1/ 25.8	33.2/ 1/ 9.9
NOX BCKGRD METER/RANGE/PPM	.7/ 2/ .7	1.9/ 1/ .4	1.5/ 1/ .4	1.5/ 1/ .4
DILUTION FACTOR	12.52	20.58	14.29	21.31
THC CONCENTRATION PPM	40.	5.	12.	4.
CO CONCENTRATION PPM	231.	59.	79.	49.
CO2 CONCENTRATION PCT	.9924	.5998	.8820	.5785
NOX CONCENTRATION PPM	32.0	11.8	25.3	9.5
THC MASS GRAMS	1.75	.38	.52	.29
CO MASS GRAMS	19.93	8.72	6.77	7.27
CO2 MASS GRAMS	1344.2	1390.2	1188.1	1340.7
NOX MASS GRAMS	4.41	2.79	3.48	2.23
THC GRAMS/KM	.30	.06	.09	.05
CO GRAMS/KM	3.44	1.40	1.17	1.16
CO2 GRAMS/KM	232.3	223.3	205.3	214.7
NOX GRAMS/KM	.76	.45	.60	.36
FUEL CONSUMPTION BY CB L/100KM	9.99	9.43	8.68	9.07
RUN TIME SECONDS	507.	868.	505.	868.
MEASURED DISTANCE KM	5.79	6.23	5.79	6.25
SCF, DRY	.974	.977	.975	.977
DFC, WET (DRY)	.976 .940(.924)		.976 .945(.929)	
TOT VOL (SCM) / SAM BLR (SCM)	200.6/ 0.00		200.1/ 0.00	
KM (MEASURED)	12.01		12.03	
FUEL CONSUMPTION L/100KM	9.71		8.88	

COMPOSITE RESULTS

TEST NUMBER		864
BAROMETER	MM HG	732.0
HUMIDITY	G/KG	9.9
TEMPERATURE	DEG C	23.9

		3-BAG	(4-BAG)
CARBON DIOXIDE	G/KM	220.2	(217.7)
FUEL CONSUMPTION	L/100KM	9.35	(9.24)
HYDROCARBONS (THC)	G/KM	.12	(.11)
CARBON MONOXIDE	G/KM	1.76	(1.69)
OXIDES OF NITROGEN	G/KM	.55	(.53)